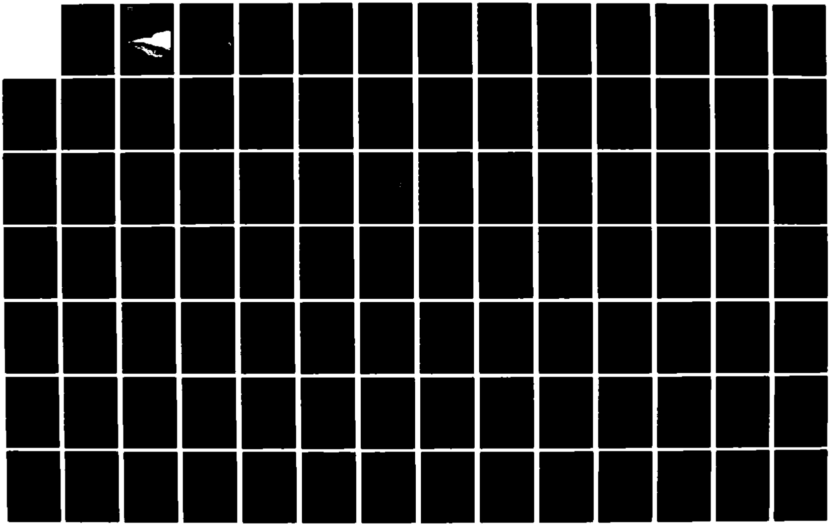
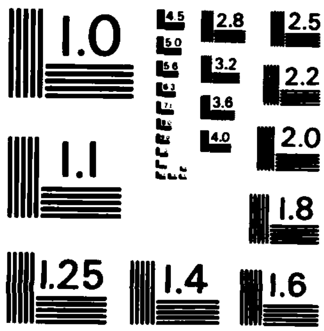
AD-A161 771 BARKLEY LAKE SURVEY CUMBERLAND RIVER MILES 35 - 47(U) 1/2
MURRAY STATE UNIV KY DEPT OF BIOLOGICAL SCIENCES
J B SICKEL 31 MAR 83 DACW62-81-C-0295

UNCLASSIFIED F/G 8/8 NL



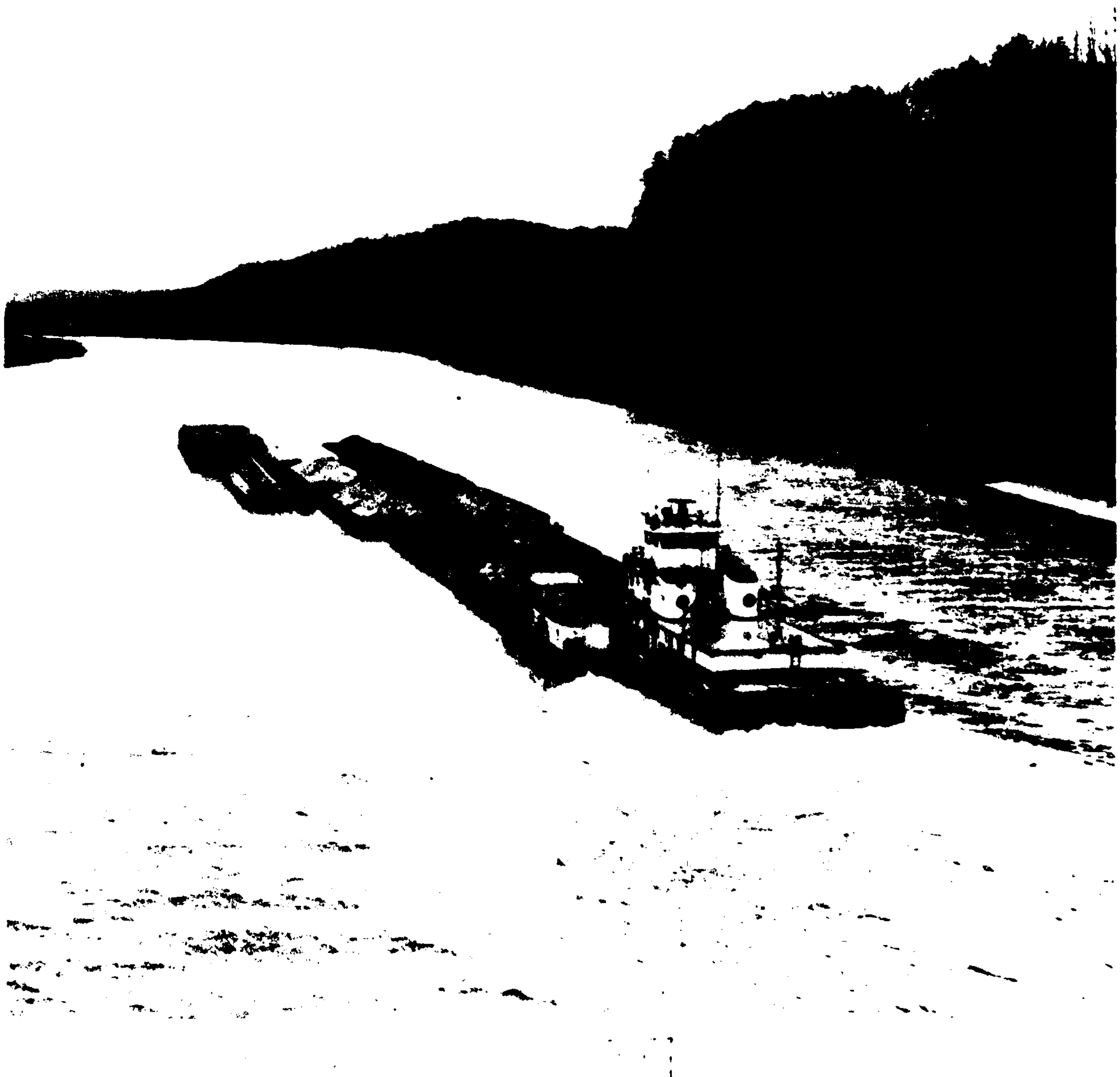


MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

US Army Corps
of Engineers
Nashville District

Phase II, Barkley Lake Survey
Cumberland River Miles 35-47

(12)



SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A161 771	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase II, Barkley Lake Survey Cumberland River Miles 35 - 47		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) James B. Sickel, Ph. D.		8. CONTRACT OR GRANT NUMBER(s) Contract No. DACW62-81-0295
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Biological Sciences Murray State University Murray, Kentucky 42071-3306		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Nashville District Corps of Engineers P.O. Box 1070 Nashville, TN 37202-1070		12. REPORT DATE March 31, 1983
		13. NUMBER OF PAGES 119
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

DTIC ELECTE NOV 25 1985 S D A

18. SUPPLEMENTARY NOTES

Available from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Channel Improvement
Bend Removal
Environmental Effects
Freshwater Mussels
Benthic Macroinvertebrates
Deep-Channel Disposal

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Navigation improvements by the Corps of Engineers may include the removal of old river bends in multi-purpose reservoirs. This report examines the impact of proposed bend removal, shallow embayment disposal and deep channel disposal of dredged material, on benthic macroinvertebrates, including freshwater mussels, in Lake Barkley on the Lower Cumberland River.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

FINAL REPORT

PHASE II, BARKLEY LAKE SURVEY
CUMBERLAND RIVER MILES 35-47

Submitted to:

Department of the Army
Nashville District, Corps of Engineers
Environmental Analysis Section
P. O. Box 1070
Nashville, Tennessee 37202

Contract No. DACW62-81-C-0295

Submitted by:

James B. Sickel, Ph.D.
Department of Biological Sciences
Murray State University
Murray, Kentucky 42071

March 31, 1983

ABSTRACT

This report includes an analysis of each of eight proposed work sites consisting of eight bends and channel areas between Cumberland River Miles 35 - 47. An analysis of substrate grain size composition, percent weight loss on ignition at 550°C, and benthic macroinvertebrate composition is reported for each of the work sites. A report of the mussel survey at the Eddy Creek and Clay Bay sites is also included along with an estimate of the impact of the loss of benthic macroinvertebrates on the fish fauna.

The sediments within each site were quite variable with regards to grain size. In general, however, the overbank sites had 55% of the material composed of sands greater than 0.063mm diameter while the channel sites had 94% silt and clay smaller than 0.063mm. The overbank organic content of the sediments (as % loss on ignition at 550°C) was almost 5% while the channel sediments contained about 9%.

The benthic macroinvertebrates averaged $800/m^2$ with a biomass of $250mg/m^2$ on overbanks and $3000/m^2$ in channel sites with a biomass of $1230mg/m^2$ or approximately 5 times that of the overbanks excluding the mussels. Although 10 - 30% of fish production can be attributed to benthic macroinvertebrates, it was estimated that even a complete loss of the benthic fauna for a year at the Eddy Creek bend site would have an insignificant impact on the commercial and sport fishery of Barkley Lake.

The preimpoundment mussel fauna has essentially disappeared from the channel as a result of siltation. The overbank mussel fauna is gradually developing (10 species were collected), but has not reached its potential diversity or density. No endangered species were found, but several sites with a high percent of sand appeared to provide potentially suitable habitats.

ACKNOWLEDGEMENTS

The Murray State University students who performed the majority of the fieldwork and analyses deserve special thanks. They are Carol C. Chandler and Garry L. Pharris who conducted the SCUBA diving, mussel and sediment analyses, and Mark F. Boone, Carlos A. Peralta, James W. Wempe and Cheryl L. Hughes who conducted the invertebrate collections and analyses. The majority of the data compilation, graphics and typing was performed by Carol Chandler to whom sincere thanks are extended. Sincere thanks are also extended to James F. Sharber and the Nashville District Corps of Engineers for providing the contract which made this investigation possible.

Table of Contents

List of Figures

List of Tables

Table		Page

Table Page

FINAL REPORT

Phase II, Barkley Lake Survey

Introduction

The Corps of Engineers proposes to dredge the inside of eight bends between CRM 35 and 47 to reduce the hazards to barge navigation resulting from the narrow channel and sharp bends. Within this section of the Cumberland River there once occurred two federally listed endangered species of mussels, Lampsilis orbiculata and Plethobasus cooperianus. Because no systematic survey has been conducted since 1914 (Wilson and Clark 1914), it is not known if they still exist in Barkley Lake. Other benthic organisms which would be directly affected by dredging provide a major source of food for fish. The purpose of this study is to determine if any suitable habitat for endangered species of mussels still exists in the proposed dredge or disposal areas and to estimate the potential impact of dredging on the benthic community which in turn would reduce food for fish.

In the initial planning of the dredging operations, at least at the site located at the mouth of Eddy Creek (Cumberland River mile 46.5), two alternative disposal methods were being considered - deep channel disposal and shallow overbank or embayment disposal. The second alternative would create a shallow, diked area or fill in an embayment creating a marsh or wetland for wildlife. During the dredging operation, quantities of silt, sand and clay will be suspended in the water column and settle over areas containing mussels and other benthic macroinvertebrates. Another objective of this investigation was

to determine the characteristics of the sediments which potentially could be suspended at each of the proposed dredge sites.

There is little information available on the effects of brief exposures to dredging and dredge spoil on aquatic organisms. It is probably safe to assume that organisms passing through the cutter-head type suction dredge will perish as will the organisms covered by a deep deposit of spoil. However, under some circumstances, freshwater mussels and perhaps other burrowing forms can dig their way to the surface of deposited sediments if the overlay is not too thick and the period of sedimentation is brief. Marking and Bills (1980) demonstrated that the fat mucket (*Lampsilis radiata luteola*) and the pocketbook (*Lampsilis ventricosa*) could emerge from an overlay of 17.5cm of sand or silt with a 50% rate of survival while 50% of pig-toes (*Fusconaia flava*) could emerge from only a 10cm deep overlay.

Although it has been observed that mussels can feed in water containing a heavy silt load (Churchill and Lewis 1924), and particles such as coal dust can pass through their gut with no apparent ill effect (Williams 1969), it is generally agreed that chronic exposure to silt is detrimental to mussels (Fuller 1974). Yokley and Gooch (1976) noted reduced growth rate in mussels located downstream from a sand and gravel dredging operation in the Tennessee River, and Williams (1969) reported a complete absence of mussels where dredging had occurred in the Ohio River. Chronic conditions resulting in a silt overlay of only a few centimeters was sufficient to kill mussels in an experiment reported by Ellis (1936).

During brief dredging operations of a few weeks or even months, mussels in the downstream vicinity that were not completely covered by a permanent

overlay would probably survive. However, if dredging occurred during spawning season there would likely be reduced reproductive success for mussels in the area affected by suspended silt. One reason is that potential host fish for the mussel glochidia would avoid the area. Also, disturbing the gravid females may result in abortion of larvae. The larvae in the gills of the gravid female mussel are very susceptible to silt and pollution, and newly transformed juveniles of many species must have a relatively silt free bottom on which to settle for successful survival (Ellis 1931).

The turnover, or production/mean biomass ratio, of other benthic invertebrates is much more rapid than that of the mussels - reproduction occurring in one year or less as compared to 6 - 10 years for many of the mussels. This and the more dynamic nature of most of the invertebrate populations make it likely that dredging operations will have only a short term impact on invertebrates other than mussels. Yokley and Gooch (1976) noted a rapid replacement of macrobenthos - arthropods, annelids, flatworms and coelenterates - in areas affected by dredging.

The environment of the Eddy Creek Bend, Bend A (CRM 45.8 - 47.0), is one which has often experienced change. In 1914 Wilson and Clark reported finding <u>Lampsilis orbiculata</u> and <u>Plethobasus cooperianus</u> on gravel bars in the vicinity of Eddy Creek. They found <u>L. orbiculata</u> above Kuttawa (about CRM 42) and <u>P. cooperianus</u> at Horse Ford below Kuttawa (about CRM 36). Both of these sites were located below Old Lock and Dam F at Eddyville (CRM 43.6). Flow in the Eddy Creek channel has been altered since the construction of that dam. What is now the inundated overbank was a field with trees bordering the river channel up to the time of the construction of Barkley Dam. Lake Barkley began filling on July 1, 1964, when the construction cofferdam was closed, and

minimum pool elevation of 354.0 feet was reached on February 16, 1966 (U.S. Geol. Survey 1979). The overbanks have remained inundated since then, and both the overbank and channel have undergone major changes with a concomitant shift in the aquatic fauna.

The shift in the mussel fauna from a large river assemblage to an impoundment assemblage is a common occurrence when large rivers are impounded. When Kentucky Lake was approximately the same age as Barkley Lake at present, Bates (1962) reported a significant loss of many of the river species and only eight species beginning to populate the shallows and overbanks (Quadrula quadrula, Proptera laevissima, Leptodea fragilis, Carunculina parva, Truncilla donaciformis, Anodonta grandis corpulenta, Anodonta imbecillis and Anodonta suborbiculata). Since that time more species have adapted to the "lake" habitats while the mussel fauna of the main channel has been nearly exterminated. Chandler (1982) found 19 species inhabiting Kentucky Lake with Q. quadrula, Amblema plicata and Megalonaias gigantea being by far the most abundant. Similar changes can be expected for Barkley Lake.

The impact of dredging on the fish fauna is difficult to predict. It is assumed that fish will avoid the immediate area of dredging activities and areas where suspended silt becomes intolerable. However, there may be an indirect impact through loss of food items during and for some time after dredging is completed.

If the suspended silt load remains high for an extended period of time it is possible that primary production of the phytoplankton may be reduced as a result of reduced light penetration. On the other hand, sediment suspension may increase nutrient levels which may stimulate production. Yokley and Gooch (1976) noted that plankton densities were little affected by sand and gravel dredging.

The loss of invertebrate fish food will probably represent the greatest impact of dredging on the fish. The reported catch value of the Kentucky section of the Barkley Lake net fishery for 1980 - 81 was $285,000 of which 90% consisted of buffalofish, catfish and carp (Johnson and Bronte 1982) all of which depend largely on benthic macroinvertebrates during some phase of their life cycle (Pflieger 1975). The potential impact of the loss of benthic fauna as a result of dredging can be estimated by examining the biomass of benthic fauna at the proposed dredge sites compared with the fauna at control sites. The fraction of the area of suitable habitat to be dredged will be an estimate of the impact of dredging on the invertebrate fauna which in turn could be considered to have an equivalent impact on the fish.

An assumption might be that there would be an equivalent fractional loss in growth of the fish for the year in which dredging occurred, and that a similar loss in catch weight would reduce the value of the catch proportionally. Whether or not the losses would be equivalent would depend on the ability of the fish to forage at other sites. If the fish density is low, then it is likely that they will forage elsewhere, and the loss of the benthic fauna to dredging would result in a less than equivalent loss in the fish weight gain. However, if the fish density is high, the dredging might force fish into an even more crowded condition in which increasing competition might result in a greater than equivalent loss in weight until the benthic fauna becomes reestablished. Since the population structure of the various fish species and intensity of competition is not known, it will be assumed that a loss of a fraction of the benthic fauna will result in an equivalent fractional loss in the fish fauna.

Methods

For purposes of identification of proposed dredge sites, each bend was designated by an identification letter (Table 1). Eddy Creek bend, being the first surveyed, was designated Bend A. Individual grab sites were given numeric designations which preceded the bend designation. Thus the first grab taken at the Eddy Creek site was designated 1A, the second 2A and so forth sequentially. SCUBA dive sites were designated only by numerals. Figure 1 shows the locations of the bends.

Substrate sampling was accomplished using a $0.05m^2$ Ponar grab attached to a hydraulic winch mounted on a 8.5m (28 ft) pontoon boat. Grab sites were located along the long axis of the work area on the overbank and in the main channel at approximately 75m intervals. Two grabs were collected at each grab site, one for invertebrate analysis and one for sediment analysis. One to four additional grabs were taken from each bend for invertebrate identification and further studies.

Macroinvertebrates were concentrated by sieving each grab sample through a 0.47mm wash bucket and initially preserving in 7% formalin. In the laboratory the preserved samples were further washed in a 0.35mm soil sieve, and the invertebrates were picked out with the aid of a magnifying lens and dissecting microscope and stored in 40% isopropyl alcohol. Invertebrates were then identified to the lowest taxa possible. Numbers of each taxon were recorded; all individuals of each taxon were dried overnight at 65 - 70°C. Dry weight biomass was determined with an Ainsworth analytical balance to the nearest 0.1mg or with a Mettler analytical balance to the nearest 0.01mg.

The mussel survey of the overbank of Eddy Creek Bend, CRM 45.8 - 47.0,

Table 1. Bend designations for Phase II of Barkley Lake Survey, Cumberland River miles 35 - 47.

Name	Bend Designation	Cumberland River Mile
Eddy Creek Bend	A	45.8 - 47.0
Eddyville Bend	B	43.3 - 44.2
Lick Creek Bend	C	42.4 - 43.3
Hammonds Light Bend	D	41.8 - 42.7
Kuttawa Bend	E	40.4 - 41.4
Poplar Creek Bend	F	39.5 - 40.5
Money Cliff Bend	G	38.8 - 39.2
Big Horse Ford Light Bend	H	35.7 - 37.0

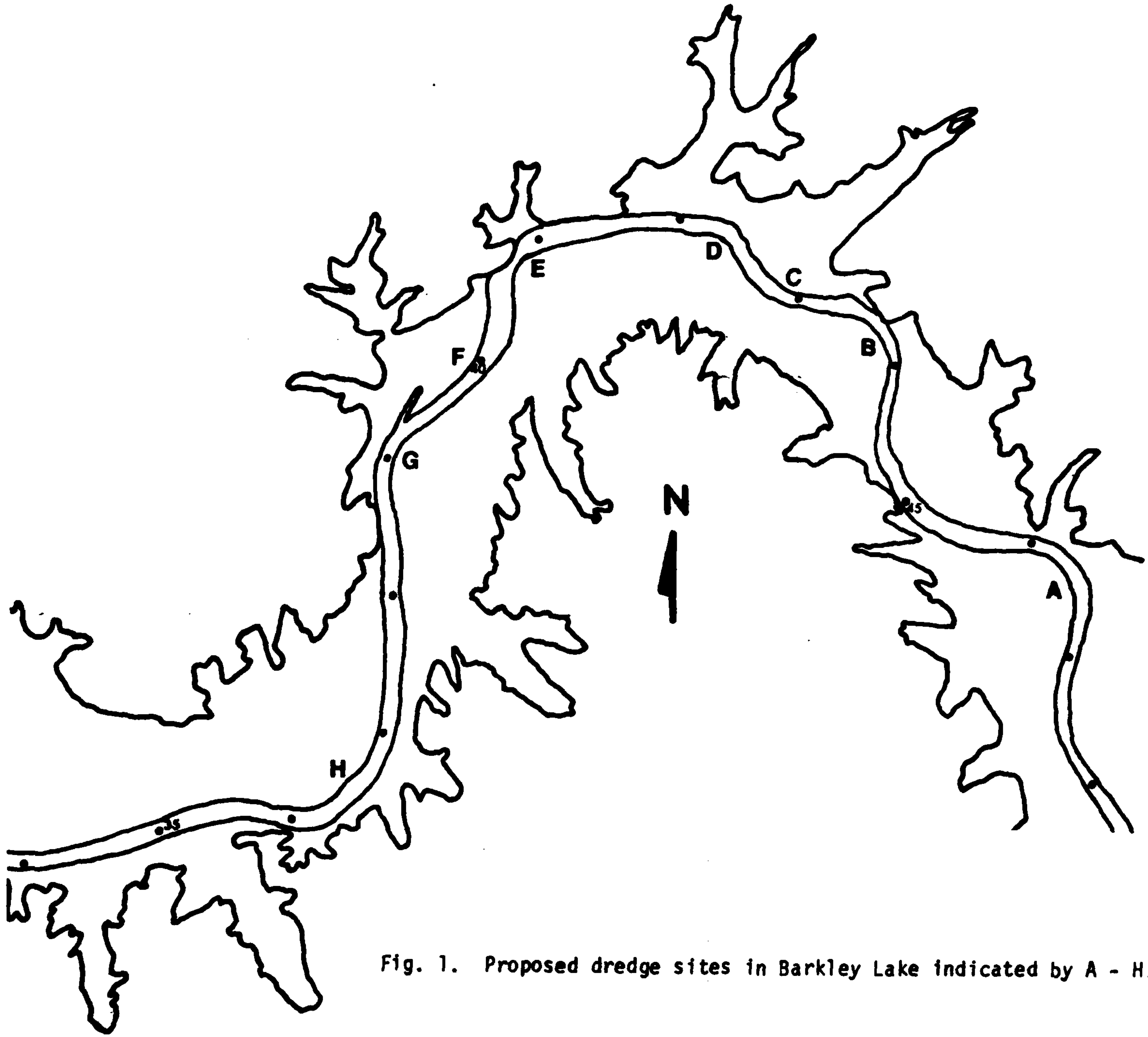


Fig. 1. Proposed dredge sites in Barkley Lake indicated by A - H.

and Clay Creek Bay was conducted by SCUBA divers. At the proposed Eddy Creek dredge site divers collected all mussels found along a 40 - 70m line placed on the lake floor at 75 - 150m (250 - 500 ft) intervals at right angles to the Cumberland River channel. The channel adjacent to the Eddy Creek bend was sampled with a 12' brail equipped with "rock" hooks. The brail was towed with a 16' aluminum john boat equipped with a 40 hp motor. Mussels were collected randomly by divers from four sites in Clay Creek Bay (Fig. 2). All live mussels collected were aged and the length determined to the nearest 0.1mm with a dial caliper. Representative shells are stored in the museum collection in the Biology Department at Murray State University, Murray, Kentucky.

Sediment samples were collected using a Ponar grab at each of the grab sites where benthic invertebrate samples were taken. After Eddy Creek bend samples were analyzed for organic matter, the original overbank sediment was accidentally discarded before grain size was determined which necessitated the collection of new samples from the Eddy Creek overbank. The new grab samples were designated 1AX - 9AX as opposed to the original samples in which only the letter A succeeded the grab number. The locations for the new grab sites were approximately the same as those of the SCUBA dive sites. Each sample respresented a composite of sediment from the sediment surface to a depth of approximately 15cm.

Sediment grain size compositon was determined by first wet sieving a representative sample from each grab site through a series of sieves down to 0.063mm. The pipet method as described by Guy (1969) was used to determine the percent silt and clay. Grain sizes, reported in mm, were scaled according to Folk's 1974 classification and are listed in Table 2 along with Phi (ϕ) conversions ($\phi = -\log_2$ particle diameter in mm). All

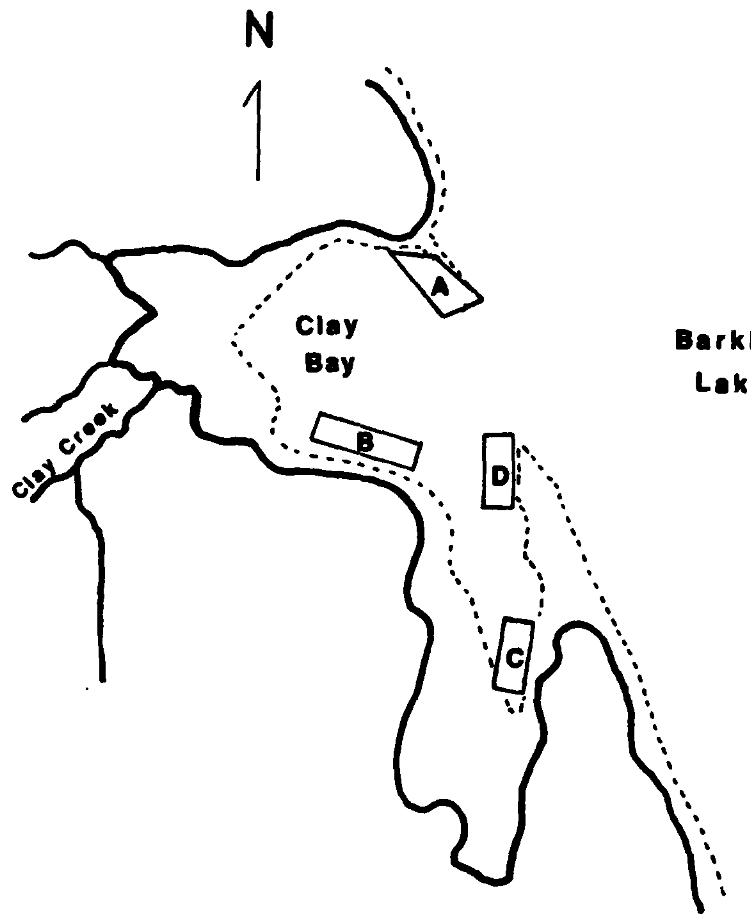


Fig. 2. Clay Bay sample sites. Area between shoreline and dotted contour line represents bottom elevations from 354' to 359'.

Table 2. Grain size classification, including Phi (ϕ) conversion scale, used in Barkley Lake Survey particle size analysis.

Particle Size				Size Class
Millimeter scale		Phi scale		
Greater than	but less than	less than	but greater than	
1.00	2.00	0.0	-1.0	Very coarse sand
0.50	1.00	1.0	0.0	Coarse sand
0.25	0.50	2.0	1.0	Medium sand
0.125	0.25	3.0	2.0	Fine sand
0.0625	0.125	4.0	3.0	Very fine sand
0.031	0.0625	5.0	4.0	Coarse silt
0.016	0.031	6.0	5.0	Medium silt
0.008	0.016	7.0	6.0	Fine silt
0.004	0.008	8.0	7.0	Very fine silt
0.002 or less		9.0 or greater		Clay

channel sites appeared to be homogeneous in character; therefore, particle size was determined for only one or two channel samples per bend.

Percent organic matter was determined by first drying a soil sample (15 - 50g) at 100°C overnight after which the sample was ground with a mortar and pestle and placed in a crucible. The sample and crucible were weighed to the nearest 0.1mg with an Ainsworth analytical balance before being placed in a 550°C muffle furnace for approximately one hour. After ashing, the remaining sample in its crucible was placed in a dessicator to cool. The cooled crucible and sample were weighed and the percent combustible matter was calculated and reported to the nearest 0.1%.

Results and Discussion of Individual Bends

This section is divided into analyses of each bend and includes for each bend a site description, sediment analysis, and macroinvertebrate analysis and discussion. All phyla and lower taxonomic divisions collected are listed in Table 3. Refer to this table for higher taxonomic divisions than those listed in subsequent tables. These later tables of benthic macroinvertebrate density and biomass list only the lowest taxa identified.

Table 3. Macroinvertebrates collected by Ponar grab from proposed dredge sites and adjacent channel areas in Barkley Lake.

- Platyhelminthes
  - Turbellaria
    - Tricladida
      - Planariidae
        - *Dugesia tigrina*
- Nematoda
- Annelida
  - Oligochaeta
    - Haplotaxida
      - Tubificidae
        - *Branchiura sowerbyi*
        - Other Tubificidae
      - Naididae
  - Hirudinea
- Arthropoda
  - Crustacea
    - Isopoda
  - Arachnoidea
    - Hydracarina
  - Insecta
    - Ephemeroptera
      - Ephemeridae
        - *Hexagenia bilineata*
    - Odonata
      - Anisoptera
    - Hemiptera
    - Trichoptera
      - Leptoceridae
        - *Oecetis* sp.
      - Polycentropodidae
        - *Cyrnellus* sp.
    - Diptera
      - Culicidae
        - *Chaoborus* sp.
      - Chironomidae
        - Chironominae
          - *Chironomous* sp.
          - *Cryptochironomus* sp.
          - *Polypedilum* sp.
          - *Xenochironomus* sp.
        - Tanypodinae
          - *Ablabesmyia* sp.
          - *Clinotanypus* sp.
          - *Coelotanypus* sp.
          - *Procladius* sp.
          - *Tanypus* sp.
      - Unknown Chironomidae
      - Ceratopogonidae (Heleidae)
- Mollusca
  - Gastropoda
    - Megagastropoda
      - Hydrobiidae
      - Pleuroceridae
        - *Pleurocera canaliculatum excuratum*
  - Pelecypoda
    - Corbiculidae
      - *Corbicula fluminea*
    - Sphaeriidae
    - Unionidae
      - Ambleminae
        - *Amblema plicata*
        - *Quadrula nodulata*
        - *Quadrula quadrula*
      - Unioninae
        - *Truncilla donaciformis*

Mussel Survey of Eddy Creek Bend and Clay Creek Bay

Live specimens of nine species and shells of two additional species, *Leptodea fragilis* and *Elliptio crassidens*, were collected by SCUBA divers from the Eddy Creek bend overbank (Tables 4 and 5). One *Elliptio crassidens* shell was found among numerous *Megalonaias gigantea* shells in a preimpoundment cull pile at dive site #4 (Fig. 3). Neither live specimens nor shells of any endangered species were collected. *Corbicula fluminea* shells were numerous at all dive sites; however, only one live *Corbicula* was collected by diving.

Only one live mussel, *Anodonta grandis*, was collected by brail in the Eddy Creek bend section of the main river channel. Silt accumulation in the channel since impoundment has certainly contributed to the demise of pre-impoundment species and has prevented settlement of the channel by juveniles. The loose silt may bury mussels which aren't able to maintain their body position at the sediment - water interface. Species such as *Anodonta grandis* which have thin, light shells with a wide diameter may be able to stabilize themselves in the loose sediment. The gills of both adults and juveniles may become clogged by the silt contributing to the death of channel mussels. Isom (1969) reported four feet of sediment in the channel of Kentucky Lake, Kentucky, at TRM 31.7, and Chandler (1982) reported only four species from the channel of the Kentucky portion of Kentucky Lake compared to 19 species found in the less silt-laden postimpoundment habitats.

The four sites sampled by SCUBA divers at Clay Creek Bay (Fig. 1), CRM 46.4 - 47.0, on the west side of the lake yielded four species of unionid mussels and one live *Corbicula fluminea*. Single shells of two

Table 4. Number of mussels per species found at proposed Eddy Creek dredge site.

Dive Site #	*Amblema plicata*	*Anodonta grandis*	*Anodonta suborbiculata*	*Arcidens confragosus*	*Elliptio crassidens*	*Leptodea fragilis*	*Megalonaias gigantea*	*Obliquaria reflexa*	*Quadrula nodulata*	*Quadrula quadrula*	*Tritogonia verrucosa*
1	2	.	.	.	.	1s*	4	.	1,1s	3	1
2	1s	.	.	.	.	.	.	.	.	.	.
3	.	.	.	.	.	.	.	.	1	3	.
4	2	2	.	1	**	.	**	.	1	4	.
5	.	.	.	.	.	.	.	1,1s	5	6	.
6	1	.	.	.	.	1s	2	1s	.	3	.
7	1	1	.	.	.	.	.	.	.	1	.
8	5	.	1	.	.	.	1	2	.	8	.
9	2	1	.	.	.	1s	1	1	.	8,1s	.
Totals:											
Live	13	4	1	1	0	0	8	4	8	36	1
Shells	1	0	0	0	1	3	?	2	1	1	0

* s - shell only
** found in a preimpoundment cull pile

Table 5. Age and length of individual mussels collected at proposed Eddy Creek dredge site.

Species	Age (yrs)	Length (mm)
Amblema plicata	11	122.9
	7	113.2
	10+	119.6
	9+	123.8
	10+	108.8
	10	96.1
	10	145.0
	7	99.3
	11	125.2
	15	140.0
	12	135.0
	11	92.3
	8	97.5
	10	105.1
Anodonta grandis	3	99.0
	4+	100.6
	4+	100.8
Anodonta suborbiculata	4	97.2
Arcidens confragosus	7+	114.8
Megalonaias gigantea	15	170.0
	16	170.0
	9	135.0
	14	140.0
	4	42.2
	14	168.0
	13+	186.0
	11+	187.0
Obliquaria reflexa	3	44.0
	11	51.1
	8	48.4
Quadrula nodulata	8	68.0
	7	55.9
	6	52.4
	6	50.0
	9	67.6
Quadrula quadrula	8+	82.7
	3	46.3
	9	93.7
	7+	68.8

Table 5. cont'd

Quadrula quadrula cont'd	7	56.0
	9+	81.1
	9+	72.4
	5	59.0
	9+	73.8
	6+	70.7
	10-11	79.1
	12	79.0
	8	62.7
	9	78.2
	7	62.3
	10	76.4
	9-10	86.1
	8	68.3
	8	75.3
	10	67.0
	8	68.6
	5	39.6
	7	67.4
	5-6	51.0
	4	52.8
	10-11	101.3
	5	47.5
	12-13	75.1
	12-13	82.4
	6	61.0
	5	53.2
	10	67.2
	5	47.0
	4	41.2
	5	51.1
	3	25.9
Tritogonia verrucosa	5+	131.2

other unionids, Anodonta grandis and Obliquaria reflexa, were also collected (Tables 6 and 7).

Quadrula quadrula, the mapleleaf, was the most abundant species at both the Eddy Creek bend overbank and Clay Creek Bay. Quadrula quadrula composed over 47% of the overbank mussel community and over 78% of the Clay Creek Bay mussel community. Amblema plicata, although found in much less abundance, was the second most abundant species at both collection sites.

All age classes of Quadrula quadrula were found except the 0 - 2 year class which was possibly overlooked by divers because of the small size of juvenile mussels. The Quadrula quadrula population appears to be increasing in numbers in the postimpoundment habitats as has been reported by Bates (1962) and Sickel and Chandler (1982) in Kentucky Lake.

Table 6. Number of mussels per species found at Clay Bay sample sites.

Dive Site	Species: *Amblema plicata*	*Anodonta grandis*	*Anodonta suborbiculata*	*Quadrula nodulata*	*Quadrula quadrula*	*Obliquaria reflexa*
A	2	2s*	1	.	17	.
B	.	.	1,1s	.	1	.
C	.	.	.	.	.	.
D	4	.	.	1	12	1s
Totals:						
Live	6	0	2	1	30	0
Shells	0	2	1	0	0	1

* s - shell only

Table 7. Age and length of individual mussels collected at Clay Creek Bay.

Species	Age (yrs)	Length (mm)
Amblema plicata	7	79.5
	9	101.8
	8	97.2
	11	121.2
	10	112.9
	12	124.1
Anodonta suborbiculata	5	91.3
	5	99.7
Quadrula quadrula	8	83.2
	10	84.2
	7	81.1
	5	62.2
	7	75.2
	7	75.1
	7	74.1
	8	78.5
	8	81.7
	10	84.9
	8	92.3
	8	79.1
	7	73.1
	6	58.1
	5	54.0
	5	50.2
	4	34.7
	4	45.2
	4	42.5
	3	39.4
	4	50.7
	4	52.0
	10	79.4
	10	74.3
	12	85.5
	10	81.3
	8	74.6
	9	71.5
	9	76.5
	10	90.2
	7	82.4

Bend A
Eddy Creek Bend

Site Description

The proposed dredge site at Eddy Creek bend is the west overbank of the Cumberland River channel between Cumberland River miles (CRM) 45.8 and 47.0 and is directly across the channel from the mouth of Eddy Creek (Fig. 3). Fortyfour grab samples were taken at this site, 20 from the river and 24 from the overbank. Channel sample depths (lake elevation= 359.2') ranged from 15.3m (50') to 29m (95'). Channel sites # 2 and 3 were in deeper water (24.4 - 29m) relative to the other channel sites (16.5 - 20.7m) parallel to the proposed dredge site at Bend A.

Before inundation the proposed dredge site was an old field with a tree line bordering the river. Tree stumps still remain along the old channel bank. During the mussel survey of the overbank, divers found an old garbage dump at about CRM 46.9 which contained old bottles, car parts and scrap metal. On the overbank at CRM 46.5 divers found a shell pile which was composed of shells apparently culled by mussel fishermen who brailed the river before its impoundment.

Except for areas where fine silt has accumulated, the overbank sediments are probably similar to the preimpoundment soils although no soil surveys of the area were located. The mean percentage of total sands at the overbank dredge site was 57.2% (Table 8). The remaining sediments were fine-grained (Table 9) with about 29% of the total being clay. Percent sediment organic matter was higher in the channel, 8.9%, than the overbank, 5.3% (Table 10). Allochthanous organic debris (mostly leaves and twigs) was found in most grab samples from both the channel and overbank of Bend A as it was from all other bends surveyed.

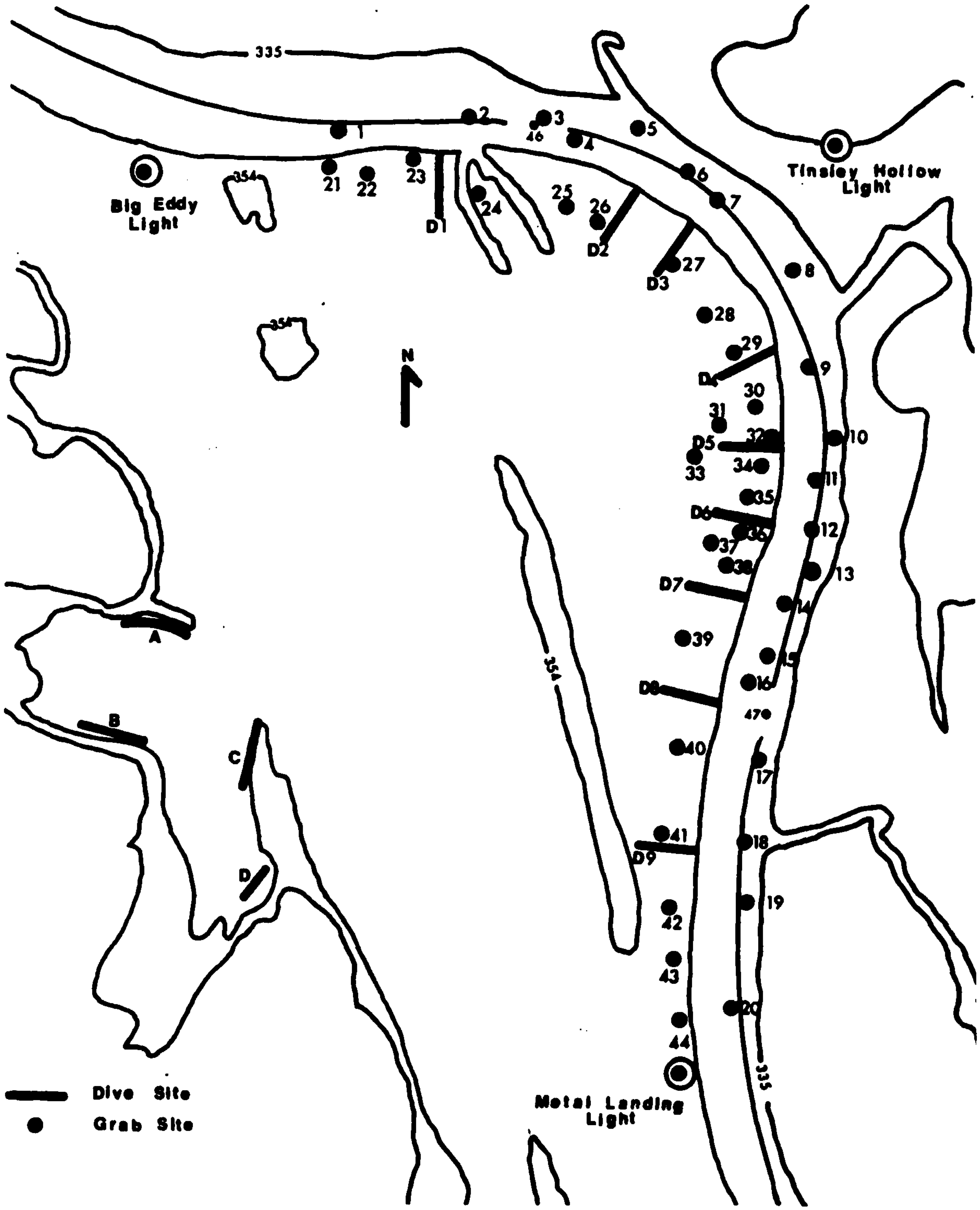


Fig. 3. Grab sample sites and dive sites for Bend A, Eddy Creek bend.

Table 8. Proposed Eddy Creek dredge site sand grain composition.

	Percent retained by sieve size (mm):					
Grab #	1.0	0.5	0.25	0.125	0.063	Total Sands
1AX	6.61	0.27	7.58	61.79	7.27	83.52
2AX	0.41	0.10	18.38	22.38	17.62	58.89
3AX	.	.	7.51	53.89	15.77	77.17
4AX	.	0.09	8.45	24.34	9.14	42.02
5AX	1.28	1.19	8.27	17.30	6.83	34.87
6AX	.	0.32	2.06	13.07	13.13	28.58
7AX	0.09	0.04	2.60	29.95	17.68	50.36
8AX	1.19	1.30	8.76	36.28	17.92	65.45
9AX	0.11	0.09	3.62	48.35	21.46	73.63
Overbank $\bar{x}$	1.08	0.38	7.47	34.15	14.09	57.16
Channel:						
8A	0.0	0.04	0.6	3.47	3.65	7.76

Table 9. Proposed Eddy Creek dredge site silt and clay grain composition.

Grab #	Pipet Size (mm) Percent finer than: 0.062	0.031	0.016	0.008	0.004	0.002
1AX	16.29	15.10	11.88	8.55	6.34	3.98
2AX	41.47	37.07	29.92	22.49	16.87	12.88
3AX	22.82	20.47	15.71	11.74	9.30	6.95
4AX	57.98	47.69	36.78	28.24	20.22	14.92
5AX	65.13	57.81	44.18	29.35	20.59	13.70
6AX	71.41	62.15	43.89	24.23	20.29	15.69
7AX	46.19	50.51	35.30	23.62	17.91	14.29
8AX	35.01	31.59	23.08	15.47	11.05	8.55
9AX	25.71	21.94	17.38	14.21	11.72	9.40
$\bar{x}$ for overbank	42.41	38.26	28.68	19.77	14.92	11.15
Channel:						
8A	86.09	83.3	68.98	53.5	40.85	29.03

Table 10. Proposed Eddy Creek Bend, Bend A, dredge site percent sediment organic matter.

Channel Grab #	% Organic Matter	Overbank Grab #	% Organic Matter
1	8.4	21	4.8
2	9.2	22	5.0
3	8.7	23	4.5
4	10.2	24	5.6
5	7.3	25	4.9
6	8.6	26	4.3
7	8.5	27	4.1
8	8.8	28	4.0
9	7.7	29	5.3
10	9.4	30	6.5
11	9.1	31	4.6
12	7.9	32	3.9
13	9.1	33	3.8
14	9.1	34	5.3
15	8.4	35	5.2
16	9.5	36	4.7
17	9.7	37	3.6
18	9.9	38	4.6
19	9.9	39	6.7
20	9.2	40	7.2
		41	6.6
$\bar{x}$	8.9		
		42	8.0
		43	11.0
		44	4.2
		$\bar{x}$	5.3

This was not included in % combustible analysis.

Macroinvertebrate Analysis

Macroinvertebrate representatives of four phyla (Nematoda, Annelida, Arthropoda, Mollusca) were collected from both the Bend A overbank (Table 11) and the adjacent channel area (Table 12). Of the overbank macroinvertebrates, members of Chironomidae (Arthropoda) were the most abundant and accounted for the majority of total biomass collected. Bend A was the only bend in which the family Chironomidae was divided into individual genera and for which biomass was determined for each genera collected. Hydrobiid gastropods and sphaeriid clams (Mollusca) also accounted for an appreciable amount of total biomass. No unionid mussels were collected from Bend A by Ponar grab. (See Mussel Survey of Eddy Creek Bend and Clay Creek Bay for the list and location of unionids collected from Bend A overbank by SCUBA divers and by brail from the channel). The total number of macroinvertebrates collected from the Eddy Creek bend overbank was 1335 individuals having a total dry weight biomass of 943.67mg, excluding the biomass of two specimens of Anisoptera and one <u>Tanypus</u> sp.; biomass was either not recorded or these specimens were too small for biomass to be determined by analytical balances available to us.

Both macroinvertebrate numbers and biomass were greater in the adjacent channel area. Tubificid worms (Annelida) were the most abundant group in the channel, but large numbers of chironomids and sphaeriid clams were also collected. Of the chironomids <u>Coelotanypus</u> was by far the most common genus collected. A total of 2664 individual invertebrates was collected which had a total dry weight biomass of 2213.98mg (excluding the weight of two isopods, which were not identified to genera, and one <u>Tanypus</u> sp. chironomid).

Table 11. Density ($\#/m^2$) and biomass (mg/m^2) of macroinvertebrates collected from the overbank of Bend A, Eddy Creek Bend (N=24).

Taxa	Number Collected ($1.2m^2$)	Biomass Collected ($mg/1.2m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	7	0.15	5.83 ± 2.00	0.12 ± 0.07
Branchiura sowerbyi	4	1.1	4.17 ± 2.63	0.92 ± 0.55
Other Tubificidae	256	37.95	213.33 ± 72.79	31.62 ± 12.03
Naididae	4	2.1	3.33 ± 1.92	1.75 ± 0.99
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	-	-	-	-
Hexagenia bilineata	15	153.05	12.5 ± 4.05	127.54 ± 116.21
Anisoptera	2	*	1.67 ± 1.13	.
Hemiptera	-	-	-	-
Oecetis sp.	6	0.71	5.0 ± 2.12	0.62 ± 0.33
Cyrnellus sp.	3	0.09	2.5 ± 1.79	0.08 ± 0.08

Table 11 cont'd

Taxa	Number Collected ($1.2 m^2$)	Biomass Collected ($mg/1.2 m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	13	0.9	10.83 ± 3.11	0.75 ± 0.27
Chaoborus sp. pupae	1	0.1	0.83 ± 0.81	0.08 ± 0.08
Chironomus sp.	255	240.81	212.5 ± 46.74	200.67 ± 82.69
Cryptochironomus sp.	39	4.74	32.5 ± 6.85	3.95 ± 0.95
Polypedilum sp.	101	2.83	84.17 ± 14.72	2.46 ± 0.69
Xenochironomus sp.	3	3.44	2.5 ± 1.79	2.87 ± 2.00
Ablabesmyia sp.	16	2.72	13.33 ± 7.61	2.27 ± 1.17
Clinotanypus sp.	-	-	-	-
Coelotanypus sp.	48	15.28	40.0 ± 7.73	12.73 ± 3.96
Procladius sp.	281	24.22	234.17 ± 34.67	20.18 ± 3.00
Tanypus sp.	1	*	0.83 ± 0.81	.
Unknown Chironomidae	159	39.27	132.5 ± 25.13	32.72 ± 7.02
Ceratopogonidae	5	0.55	4.17 ± 1.66	0.46 ± 0.23
Hydrobiidae	87	163.66	72.5 ± 10.06	136.38 ± 22.09
Pleurocera canaliculatum excuratum	-	-	-	-

Table 11 cont'd

Taxa	Number Collected ($1.2m^2$)	Biomass Collected ($mg/1.2m^2$)	Mean Density $\pm$ S.E. ($\#/m^2$)	Mean Biomass $\pm$ S.E. (mg/m^2)
Corbicula fluminea	-	-	-	-
Sphaeriidae	29	245.5	39.17 $\pm$ 10.77	204.58 $\pm$ 73.56
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	1335	939.17	1128.33	782.75

* not included in total

- not collected at this site

Table 12 Density (#/m^2) and biomass (mg/m^2) of macroinvertebrates collected from the channel of Bend A, Eddy Creek Bend (N=20).

Taxa	Number Collected (m^2)	Biomass Collected (mg/m^2)	Mean Density ± S.E. (#/m2)	Mean Biomass ± S.E. (mg/m2)
Dugesia tigrina	-	-	-	-
Nematoda	4	0.95	4.00 ± 3.03	0.95 ± 0.88
Branchiura sowerbyi	26	384.5	26.00 ± 12.00	384.5 ± 210.29
Other Tubificidae	1583	375.1	1583.00 ± 191.3	375.1 ± 45.58
Naididae	4	0.35	4.00 ± 4.2	0.35 ± 0.29
Hirudinea	-	-	-	-
Isopoda	2	*	2.00 ± 2.0	.
Hydracarina	-	-	-	-
Hexagenia bilineata	10	36.3	10.0 ± 7.2	36.3 ± 26.88
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	-	-	-	-
Cyrnellus sp.	-	-	-	-

Table 12 cont'd

Taxa	Number Collected (m^2)	Biomass Collected (mg/m^2)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	63	7.45	63.0 ± 15.2	7.45 ± 0.10
Chaoborus sp. pupae	15	2.9	15.0 ± 6.6	2.9 ± 0.06
Chironomus sp.	35	32.72	35.0 ± 9.78	32.72 ± 12.18
Cryptochironomus sp.	-	-	-	-
Polypedilum sp.	-	-	-	-
Xenochironomus sp.	19	89.4	19.0 ± 7.14	89.4 ± 28.42
Ablabesmyia sp.	113	9.27	113.0 ± 24.51	9.27 ± 1.75
Clinotanypus sp.	1	0.93	1.0 ± 0.97	0.93 ± 0.91
Coelotanypus sp.	414	331.09	414.0 ± 38.26	331.09 ± 33.72
Procladius sp.	111	12.37	111.0 ± 19.97	12.37 ± 2.13
Tanypus sp.	1	*	1.0 ± 0.97	.
Unknown Chironomidae	8	1.65	8.0 ± 3.29	1.65 ± 0.92
Ceratopogonidae	9	2.3	9.0 ± 2.6	2.3 ± 0.42
Hydrobiidae	-	-	-	-
Pleurocera canaliculatum excuratum	-	-	-	-

Table 12 cont'd

Taxa	Number Collected (m^2)	Biomass Collected (mg/m^2)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Corbicula fluminea	17	204.3	17.0 ± 2.8	204.3 ± 4.91
Sphaeriidae	229	722.4	229.0 ± 55.0	722.4 ± 158.4
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	2664	2213.98	2664.0	2213.68

* not included in total

- not collected at this site

Bend B
Eddyville Bend

Site Description

Bend B is the west overbank parallel to the river channel from CRM 43.3 - 44.2. Thirteen sites were sampled in the channel and fourteen from the overbank (Fig. 4). Overbank sample depths ranged from 3.9m to 5.8m relative to a lake elevation of 358.42'. Channel depths ranged from 19.52m to 22.87m, lake elevation = 358.64'.

Eddyville State Penitentiary is situated on a limestone bluff directly across the river channel from Bend B, and within this river section the channel runs within a few meters of the rocky bluff. Before impoundment a lock and dam, Lock and Dam F, were located at about CRM 43.7, the approximate present location of Eddyville Light. No relic remains of the old lock and dam were found during sampling.

Sediment grain composition and percent organic matter of Bend B were similar to that of Bend A. However, a few rocks up to 9.6cm in diameter were found scattered on the overbank. The overbank sediments were approximately 54% sand (Tables 13 and 14). The channel sediments averaged over 9% organic matter, and the overbank sediments were approximately 4% organic matter (Table 15). Undecomposed leaves were found in most grab samples, and *Corbicula fluminea* shells were numerous in samples taken from the north end of the overbank.

Macroinvertebrate Analysis

The same four phyla were found at Bend B as Bend A. Invertebrate densities and biomass of Bend B were comparable to Bend A except that on the overbank (Table 16) *Chaoborus* sp. were more abundant at Bend B and hydrobiid gastropods and sphaeriid clams were more abundant at Bend A.

Fig. 4. Grab sample sites for Bend B, Eddyville Bend.

Table 13. Proposed Eddyville Bend, Bend B, dredge site sand grain composition.

	Percent retained by sieve size (mm):					
Grab #	1.0	0.5	0.25	0.125	0.063	Total Sands
14B	1.66	2.10	43.46	22.53	8.29	79.70
15B	0.62	0.33	7.72	35.31	10.87	54.85
16B	2.21	0.59	34.26	19.31	7.94	64.31
17B	6.81	0.64	32.31	18.73	10.53	69.02
18B	0.16	0.26	16.30	20.12	12.34	48.18
19B	2.01	0.67	32.38	30.22	7.95	73.23
20B	0.43	0.52	19.85	25.65	13.02	59.47
21B	0.24	0.23	6.01	28.39	11.69	46.56
22B	0.62	0.36	5.93	28.73	26.13	61.77
23B	0.19	0.22	19.76	34.15	15.63	69.95
24B	0.74	0.15	2.08	18.79	21.69	43.45
25B	0.64	0.42	7.14	25.61	16.82	50.63
26B	0.43	0.12	1.09	12.43	17.98	32.05
27B	1.20	0.24	1.17	7.41	10.30	20.32
28B	.	0.39	2.26	20.86	20.43	44.33
Overbank $\bar{X}$	1.20	0.48	15.45	23.22	14.11	54.52
Channel:						
3B	0.07	0.17	0.60	1.24	2.57	4.65
7B	.	.	1.55	6.34	5.13	13.02
Channel $\bar{X}$	0.35	0.08	1.07	3.79	3.85	8.83

Table 14. Proposed Eddyville Bend, Bend B, dredge site silt and clay grain composition.

	Percent finer than:					
	Pipet Size (mm)					
Grab #	0.062	0.031	0.016	0.008	0.004	0.002
14B	21.97	20.47	16.74	12.98	9.95	7.18
15B	45.15	40.94	34.84	26.93	20.25	14.53
16B	35.69	32.21	25.16	18.20	13.28	8.00
17B	30.99	27.75	21.40	15.41	12.58	8.25
18B	51.82	48.01	38.20	26.79	18.70	12.90
19B	26.77	24.32	19.06	14.27	10.55	7.76
20B	40.52	38.49	30.25	21.60	15.44	10.51
21B	53.46	49.84	40.78	30.02	20.96	13.86
22B	38.23	34.41	24.84	16.32	10.28	6.65
23B	30.05	27.43	21.07	15.02	11.40	7.44
24B	56.54	55.13	48.08	36.29	27.19	18.43
25B	49.37	46.62	37.39	23.77	13.59	13.23
26B	67.95	63.70	49.87	35.67	22.10	17.38
27B	79.68	67.40	46.15	35.12	25.10	15.00
28B	56.06	54.18	45.98	36.37	27.78	19.38
$\bar{x}$ for overbank	45.62	42.06	33.32	24.32	17.28	12.03
Channel:						
3B	95.35	93.33	80.66	64.01	48.08	33.40
7B	87.00	85.65	72.64	56.74	40.91	15.38
$\bar{x}$ for channel	91.17	89.49	76.65	60.37	44.49	24.39

Table. 15. Proposed Eddyville Bend, Bend B, dredge site percent sediment organic matter.

Channel Grab #	% Organic Matter	Overbank Grab #	% Organic Matter
1	8.7	14	2.4
2	8.9	15	4.4
3	9.7	16	3.2
4	9.2	17	4.6
5	8.6	18	4.4
6	9.0	19	2.4
7	9.4	20	3.0
8	9.2	21	4.7
9	9.5	22	4.1
10	9.5	23	4.1
11	10.0	24	4.1
12	8.9	25	5.2
13	8.4	26	5.8
		27	6.4
$\bar{x}$	9.1	28	6.3
		$\bar{x}$	4.3

Table 16 Density (#/m^2) and biomass (mg/m^2) of macroinvertebrates collected from the overbank of Bend B, Eddyville Bend (N=14).

Taxa	Number Collected (0.7m^2)	Biomass Collected (mg/0.7m^2)	Mean Density ± S.E. (#/m^2)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	7	1.0	10.0 ± 3.91	1.43 ± 0.76
Branchiura sowerbyi	2	0.1	2.86 ± 0.41	0.14 ± 0.13
Other Tubificidae	124	41.0	177.14 ± 45.03	58.57 ± 19.99
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	-	-	-	-
Hexagenia bilineata	24	62.1	34.28 ± 11.33	88.71 ± 41.92
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	9	1.89	12.86 ± 4.78	2.7 ± 1.34
Cyrnellus sp.	-	-	-	-

Table 16 cont'd

Taxa	Number Collected ($0.7m^2$)	Biomass Collected ($mg/0.7m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	64	5.05	91.43 ± 28.04	7.21 ± 1.41
Chaoborus sp. pupae	9	0.95	12.86 ± 3.26	1.36 ± 0.37
Chironomidae	316	*	451.43 ± 45.03	.
Ceratopogonidae	-	-	-	-
Hydrobiidae	2	5.87	2.86 ± 2.75	8.38 ± 8.08
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	-	-	-	-
Sphaeriidae	9	36.35	12.86 ± 6.26	50.57 ± 25.57
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	1	6926.4*	1.43 ± 1.37	.
Anodonta imbecillis	-	-	-	-
TOTAL	567	154.31	810.01	219.07

* not included in total
\- not collected at this site

One small unionid mussel, Quadrula quadrula, was collected in grab #24 from 5.8m of water. Its biomass was not included in the total biomass because its heavy weight (for one individual) would bias the total.

The channel yielded high densities of Tubificidae, Chaoborus sp. dipterans and sphaeriid clams (Table 17). The highest mean biomass, 681.69mg/m^2, was supplied by tubificid annelids. Only one Hydracarina, water mite, and one Corbicula fluminea were collected from the channel sediments.

Chironomids were numerous at both overbank and channel sites. Individuals of the family Chironomidae were counted and mean densities calculated although genera were not categorized from Bends B - H.

Table 17. Density (#/m^2) and biomass (mg/m^2) of macroinvertebrates collected from the channel of Bend B, Eddyville Bend (N=13).

Taxa	Number Collected (0.65m^2)	Biomass Collected (mg/0.65m^2)	Mean Density ± S.E. (#/m^2)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	2	0.2	3.08 ± 2.96	0.31 ± 0.29
Branchiura sowerbyi	6	79.0	9.23 ± 4.67	121.54 ± 68.97
Other Tubificidae	1200	443.1	1846.15 ± 231.36	681.69 ± 374.98
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	1	*	1.54 ± 1.48	.
Hexagenia bilineata	-	-	-	-
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	-	-	-	-
Cyrnellus sp.	-	-	-	-

Table 17 cont'd

Taxa	Number Collected ($0.65m^2$)	Biomass Collected ($mg/0.65m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	233	27.0	358.46 ± 65.03	41.54 ± 4.15
Chaoborus sp. pupae	30	4.9	46.15 ± 8.53	7.54 ± 1.86
Chironomidae	254	*	390.8 ± 58.77	*
Ceratopogonidae	4	0.6	6.15 ± 2.56	0.92 ± 0.41
Hydrobiidae	-	-	-	-
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	1	129.8	1.54 ± 1.48	199.69 ± 191.86
Sphaeriidae	160	122.0	246.15 ± 64.88	187.69 ± 40.13
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	1891	806.6	2909.25	1240.92

* not included in total

\- not collected at this site

Bend C
Lick Creek Bend

Site Description

Lick Creek Bend is located on the northeast side of the river channel between CRM 42.4 and 43.3. Lick Creek enters the channel from NNE between CRM 42.9 and 43.0 crossing the proposed dredge site. Eighteen samples were collected from the bend overbank and eight from the channel (Fig. 5). Overbank sample depths ranged from 4.9m (16') to 8.8m (29') with the exception of one grab near the Lick Creek channel which was taken from 11.9m of water (lake elevation = 358.32'). Channel depths ranged from 19.52m to 21.35m relative to a lake elevation of 358.64'.

The overbank sediment contained less sand that either Bend A or B, 38% for Bend C (Table 18) compared to more than 50% for A and B. Channel sediments also contained less sand, less than 3%. Clay fractions (Table 19) were slightly higher for the Bend C overbank and channel while organic matter (Table 20) was in the same range as A and B.

Macroinvertebrate Analysis

Thirteen taxa of four phyla were found in grab samples from Bend C. Members of Chironomidae (Arthropoda) were the most numerous overbank taxa having a density of 461.11 individuals per square meter (Table 21), but in the channel chironomids were third in order of abundance behind tubificid annelids and _Chaoborus_ sp. dipterans. Only one specimen each of Hydracarina, Hemiptera, Ceratopogonidae, Hydrobiidae and _Corbicula fluminea_ were found at the dredge site. Of these only one, Ceratopogonidae, occurred in the channel (Table 22). One specimen each of two species of unionid bivalves, _Quadrula nodulata_ and _Quadrula quadrula_, were collected by grab from the overbank. No unionids were recovered from the channel.

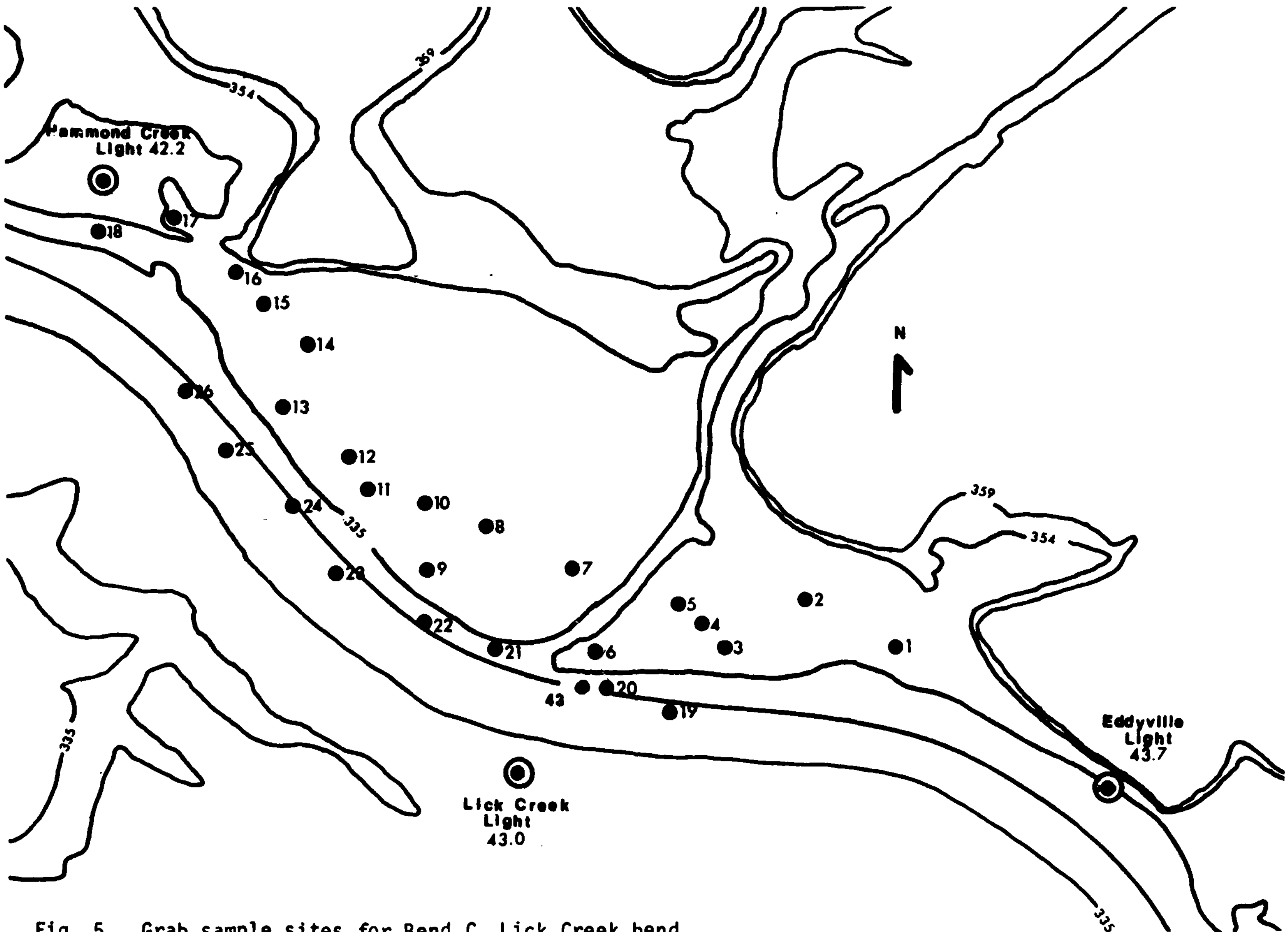


Fig. 5. Grab sample sites for Bend C, Lick Creek bend.

Table 18. Proposed Lick Creek Bend, Bend C, dredge site sand grain composition.

	Percent retained by sieve size (mm):					
Grab #	1.0	0.5	0.25	0.125	0.063	Total Sands
1C	0.00	0.00	3.48	49.28	12.79	65.55
2C	0.00	0.00	1.03	16.31	28.81	46.15
3C	0.00	0.00	1.85	21.58	28.48	51.91
4C	0.00	0.84	6.89	18.39	13.56	39.68
5C	0.00	0.15	5.72	16.18	11.97	34.02
6C	0.14	0.10	0.50	2.45	5.53	8.72
7C	0.00	0.00	3.20	24.05	24.63	51.88
8C	0.00	0.00	9.31	44.47	22.26	76.04
9C	0.00	0.11	2.02	33.02	15.35	50.50
10C	0.00	0.00	4.27	28.20	19.99	52.46
11C	0.77	0.12	0.64	8.57	20.71	30.81
12C	0.00	0.00	2.05	7.92	11.67	21.64
13C	0.44	0.15	1.55	4.84	9.53	16.51
14C	0.21	0.09	0.41	2.75	7.67	11.13
15C	1.09	0.00	0.34	2.45	6.71	10.59
16C	6.08	14.10	1.46	6.20	16.06	43.90
17C	0.26	0.15	3.36	21.07	27.10	51.94
18C	0.24	0.00	0.00	6.67	13.81	20.72
Overbank $\bar{x}$	0.51	0.88	2.67	17.47	16.46	38.01
Channel:						
19C	0.00	0.02	0.08	0.56	1.71	2.37
20C	0.00	0.02	0.08	0.84	2.45	3.39
Channel $\bar{x}$	0.00	0.02	0.08	0.70	2.08	2.88

Table 19. Proposed Lick Creek Bend, Bend C, dredge site silt and clay grain composition.

	Percent finer than (mm):					
Grab #	0.062	0.031	0.016	0.008	0.004	0.002
1C	35.18	32.23	25.70	17.28	5.53	9.94
2C	53.85	42.20	31.31	20.69	15.42	10.80
3C	48.42	40.96	28.87	18.58	13.92	9.55
4C	60.33	51.50	38.13	25.55	18.87	13.67
5C	55.97	62.26	47.12	31.22	21.82	15.54
6C	91.28	86.75	66.72	66.72	39.56	27.53
7C	48.13	48.46	43.79	37.44	30.12	21.67
8C	23.95	35.67	4.97	3.16	2.62	*
9C	49.51	47.19	37.86	29.08	20.99	15.33
10C	47.54	48.35	37.15	30.20	23.31	20.14
11C	69.19	66.90	52.58	37.40	27.91	19.47
12C	78.36	74.56	60.03	44.14	32.37	22.55
13C	83.50	84.24	70.31	47.46	33.63	23.29
14C	88.86	86.13	70.62	49.49	34.02	23.34
15C	89.40	85.64	43.43	26.60	20.80	14.88
16C	56.10	53.48	41.92	30.14	22.44	15.86
17C	48.06	41.14	31.63	22.19	16.40	12.12
18C	79.29	66.59	50.78	36.49	26.52	18.83
Overbank $\bar{x}$	62.05	58.57	43.49	31.88	22.57	17.32
Channel: 19C	97.63	96.15	84.51	68.32	54.33	38.80
20C	96.60	99.66	85.72	70.28	55.27	39.53
Channel $\bar{x}$	97.11	97.90	85.11	69.30	54.80	39.16

* sample container was broken before sample was weighed.

Table 20. Proposed Lick Creek Bend, Bend C, dredge site percent sediment organic matter.

Overbank Grab #	% Organic Matter	Channel Grab #	% Organic Matter
1	5.3	19	8.4
2	5.0	20	8.9
3	5.7	21	9.6
4	5.8	22	9.2
5	5.8	23	10.0
6	7.9	24	9.9
7	5.3	25	9.4
8	4.0	26	9.8
9	4.3	$\bar{x}$	9.4
10	5.2		
11	6.5		
12	6.4		
13	6.4		
14	7.2		
15	7.1		
16	8.9		
17	5.6		
18	7.0		
$\bar{x}$	6.1		

Table 21. Density (#/m2) and biomass (mg/m2) of macroinvertebrates collected from the overbank of Bend C, Lick Creek Bend (N=18).

Taxa	Number Collected ($0.9m^2$)	Biomass Collected ($mg/0.9m^2$)	Mean Density ± S.E. (#/m2)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	11	0.9	12.22 ± 3.89	1.0 ± 0.39
Branchiura sowerbyi	-	-	-	-
Other Tubificidae	7	1.44	5.0 ± 3.06	1.6 ± 0.78
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	1	0.05	1.11 ± 1.08	0.05 ± 0.05
Hexagenia bilineata	29	111.14	32.22 ± 8.18	123.49 ± 50.39
Anisoptera	-	-	-	-
Hemiptera	1	*	1.11 ± 1.08	.
Oecetis sp.	3	1.26	3.33 ± 1.75	1.4 ± 1.13
Cyrnellus sp.	-	-	-	-

Table 21 cont'd

Taxa	Number Collected ($0.9m^2$)	Biomass Collected ($mg/0.9m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	44	2.12	48.89 ± 20.5	2.35 ± 1.11
Chaoborus sp. pupae	2	0.02	2.22 ± 1.48	0.02 ± 0.02
Chironomidae	415	*	461.11 ± 100.11	.
Ceratopogonidae	1	0.53	1.11 ± 1.08	0.59 ± 0.57
Hydrobiidae	1	4.28	1.11 ± 1.08	4.75 ± 4.62
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	1	23.41	1.11 ± 1.08	26.01 ± 25.28
Sphaeriidae	42	90.21	46.67 ± 16.1	100.23 ± 37.48
Amblema plicata	-	-	-	-
Quadrula nodulata	1	28755.44*	.	.
Quadrula quadrula	1	50612.5 *		
Anodonta imbecillis	-	-	-	-
TOTAL	560	235.35	617.21	261.49

* not included in total
\- not collected at this site

Table 22. Density ($\#/m^2$) and biomass (mg/m^2) of macroinvertebrates collected from the channel of Bend C, Lick Creek Bend (N=8).

Taxa	Number Collected ($0.4m^2$)	Biomass Collected ($mg/0.4m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	2	0.08	5.0 ± 4.68	0.2 ± 0.19
Branchiura sowerbyi	-	-	-	-
Other Tubificidae	552	193.19	1380.0 ± 326.05	482.97 ± 104.99
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	-	-	-	-
Hexagenia bilineata	-	-	-	-
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	-	-	-	-
Cyrnellus sp.	-	-	-	-

Table 22 cont'd

Taxa	Number Collected ($0.4m^2$)	Biomass Collected ($mg/0.4m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	208	27.4	520.0 ± 44.44	68.5 ± 5.53
Chaoborus sp. pupae	28	5.35	70.0 ± 11.73	13.37 ± 2.36
Chironomidae	185	*	462.5 ± 48.66	.
Ceratopogonidae	4	0.74	10.0 ± 5.0	1.85 ± 0.92
Hydrobiidae	-	-	-	-
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	-	-	-	-
Sphaeriidae	176	164.51	440.0 ± 77.14	411.27 ± 90.82
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	1155	391.27	2887.5	978.16

* not included in total

- not collected at this site

Bend D
Hammonds Light Bend

Site Description

The proposed dredge site at Hammonds Light Bend lies south of the river channel and extends from CRM 41.8 - 42.7 (Fig. 6). Hammond Creek enters the channel from the north opposite the overbank site at CRM 42.0. Grab samples were taken from 17 overbank and six channel localities. The overbank collecting depths were shallow compared to other bend overbanks sampled. Depths ranged from 1.2m to 4.9m (lake elevation = 357.86') with the upstream portion, around CRM 42.5, being the shallowest. Channel samples were taken from water depths ranging from 18.91m to 23.18m (62' - 76'), lake elevation of 358.64'.

Sediment grain composition and percent organic matter of Bend D were similar to Bends A, B and C with sand being the major grain component of the overbank (Table 23) and silts and clays (Table 24) dominating the channel sediment assemblage. Overbank grab #5D contained a high percentage of sand, 71.27%, compared to other grabs which averaged a little over 50% sand. Organic matter was also low, 3.2%, at grab site 5D (Table 25).

Macroinvertebrate Analysis

The benthic fauna of Bend D was similar to that of the other bends surveyed with the following exceptions: eleven specimens of *Cyrnellus* sp. (Arthropoda: Insecta: Trichoptera) were collected in grab #'s 8D and 9D; one *Pleurocera canaliculatum excuratum* (Mollusca: Gastropoda) was recovered from overbank grab #8D and one from 11D; one *Amblema plicata* (Mollusca: Pelecypoda) was found in overbank grab #2D and one *Truncilla donaciformis* shell was collected in grab #17D. The Pleurocerid snails, or "river" snails are usually found in clean running water (Pennak 1978), and *Pleurocera*

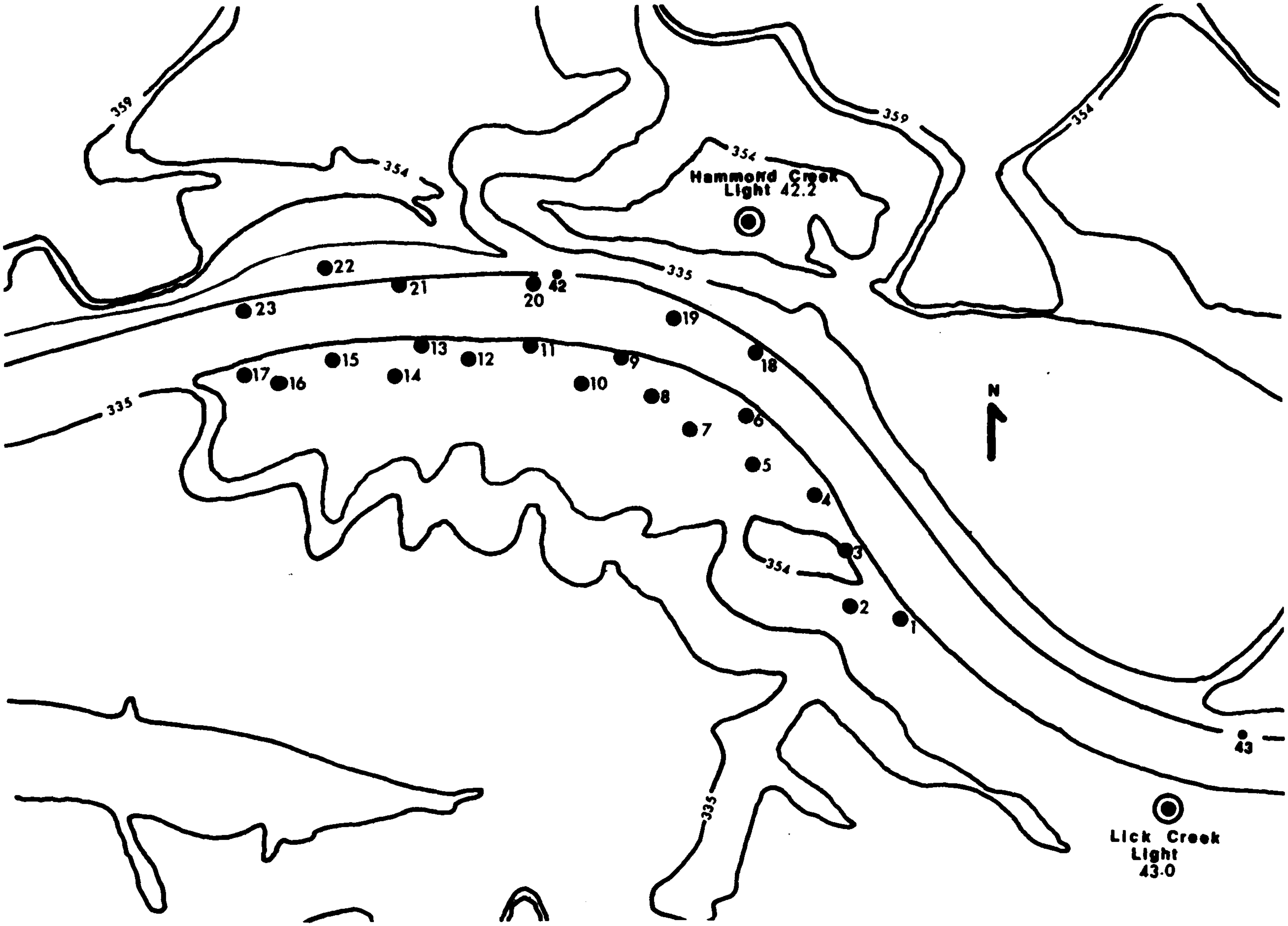


Fig. 6. Grab sample sites for Bend D, Hammonds Light Bend.

Table 23. Proposed Hammonds Light Bend, Bend D, dredge site sand grain composition.

	Percent retained by sieve size (mm):					
Grab #	1.0	0.5	0.25	0.125	0.063	Total Sands
1D	1.25	1.09	6.53	30.51	18.83	58.21
2D	9.81	2.54	10.34	15.90	13.27	51.86
3D	5.82	4.16	10.02	10.69	6.88	37.57
4D	3.30	1.16	3.30	22.06	16.72	46.54
5D	13.90	0.25	3.24	34.89	18.99	71.27
6D	3.11	1.48	8.72	21.09	17.12	51.52
7D	0.38	0.31	6.92	30.05	12.00	49.66
8D	1.55	0.40	13.96	2.73	17.33	35.97
9D	0.51	0.35	11.74	31.87	14.05	58.52
10D	0.65	1.80	21.34	27.24	13.30	64.33
11D	0.12	0.81	9.04	41.89	12.88	64.74
12D	2.02	3.23	10.82	22.11	15.17	53.35
13D	0.32	1.32	6.10	18.60	20.31	46.65
14D	14.21	3.60	5.34	15.70	19.85	58.70
15D	0.63	0.24	2.38	18.52	30.26	52.03
16D	0.17	0.18	1.37	7.41	17.34	26.47
17D	2.70	1.17	7.10	23.93	17.38	52.28
Overbank $\bar{x}$	3.55	1.42	8.13	22.07	16.57	51.74
Channel:						
18D	0.00	0.02	0.29	1.37	3.22	4.90
19D	0.00	0.04	0.16	0.95	3.26	4.41
Channel $\bar{x}$	0.00	0.03	0.18	1.16	3.24	4.65

Table 24 . Proposed Hammonds Light Bend, Bend D, dredge site silt and clay grain composition.

	Percent finer than (mm):					
Grab #	0.062	0.031	0.016	0.008	0.004	0.002
1D	41.80	33.26	23.12	14.89	10.08	6.44
2D	48.15	48.16	27.43	4.39	2.98	3.26
3D	62.45	59.88	49.43	37.15	27.82	21.00
4D	53.44	50.47	41.29	29.36	22.05	16.74
5D	28.72	23.61	17.87	12.65	8.91	5.68
6D	48.47	41.62	31.50	21.45	14.77	9.60
7D	50.33	45.02	35.16	25.99	17.99	11.89
8D	64.03	61.10	45.52	30.84	21.14	13.73
9D	41.49	37.85	29.41	20.20	13.67	9.84
10D	-	35.66	25.95	9.35	4.95	-
11D	35.98	33.00	25.30	18.27	14.00	11.06
12D	46.64	-	36.92	26.91	19.76	15.05
13D	53.34	50.33	39.06	29.12	22.11	16.60
14D	41.31	35.49	27.55	21.24	16.52	13.23
15D	47.96	43.78	34.92	27.03	20.31	15.22
16D	73.52	65.17	55.17	42.10	29.39	20.26
17D	47.73	43.55	37.25	29.11	20.65	14.45
Overbank $\bar{x}$	49.08	44.25	34.28	23.53	16.89	12.75
Channel:						
18D	-	95.30	83.26	66.71	51.62	36.94
19D	-	95.82	84.78	66.51	50.67	35.01
Channel $\bar{x}$	-	95.56	84.02	66.61	51.14	35.97

Table 25. Proposed Hammonds Light Bend, Bend D, dredge site percent sediment organic matter.

Overbank Grab #	% Organic Matter	Channel Grab #	% Organic Matter
1	4.0	18	9.3
2	5.0	19	9.5
3	9.8	20	9.7
4	5.4	21	10.3
5	3.2	22	9.7
6	4.1	23	4.4
7	5.6	24	9.5
8	5.0	$\bar{x}$	8.9
9	4.1		
10	3.8		
11	11.3		
12	5.8		
13	6.7		
14	5.2		
15	5.5		
16	6.4		
17	5.4		
$\bar{x}$	5.7		

canaliculatum excuratum is common in the Cumberland River from Nashville, Tennessee, to parts of the river in Kentucky (Burch 1982). These discoveries indicate that the overbank of Bend D (Table 26) may have a more diverse fauna than the other bends surveyed, and the habitat may also be suitable for endangered mussel species. The channel fauna (Table 27) was very similar in composition and density to neighboring bend channel areas. Tubificid annelids were again the dominant macroinvertebrates having a mean density of 2040 individuals per square meter and a mean biomass of 808.77mg per square meter.

Table 26. Density (#/m^2) and biomass (mg/m^2) of macroinvertebrates collected from the overbank of Bend D, Hammonds Light Bend (N=17).

Taxa	Number Collected (0.85m^2)	Biomass Collected (mg/0.85m^2)	Mean Density ± S.E. (#/m^2)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	9	1.58	10.59 ± 5.29	1.86 ± 1.11
Branchiura sowerbyi	3	2.0	3.53 ± 1.85	2.35 ± 1.85
Other Tubificidae	39	9.0	45.88 ± 20.35	10.58 ± 5.08
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	-	-	-	-
Hexagenia bilineata	2	3.65	2.35 ± 1.56	4.29 ± 3.94
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	3	0.59	3.53 ± 1.85	0.69 ± 0.61
Cyrnellus sp.	11	0.87	12.94 ± 8.95	1.02 ± 0.69

Table 26 cont'd

Taxa	Number Collected ($0.85m^2$)	Biomass Collected ($mg/0.85m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	37	1.83	43.53 ± 11.55	2.15 ± 0.53
Chaoborus sp. pupae	16	1.67	18.82 ± 5.38	1.96 ± 0.63
Chironomidae	212	*	249.41 ± 100.78	.
Ceratopogonidae	-	-	-	-
Hydrobiidae	39	62.09	45.88 ± 16.62	73.05 ± 22.81
Pleurocera canaliculatum excuratum	2	4151.47*	2.35 ± 1.56	*
Corbicula fluminea	3	0.81	3.53 ± 3.42	0.95 ± 0.92
Sphaeriidae	5	3.83	5.88 ± 2.21	4.51 ± 2.97
Amblema plicata	1	*	1.18 ± 1.14	.
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	382	87.92	449.4	103.41

* not included in total

\- not collected at this site

Table 27. Density (#/m^2) and biomass (mg/m^2) of macroinvertebrates collected from the channel of Bend D, Hammonds Light Bend (N=6).

Taxa	Number Collected (0.3m^2)	Biomass Collected (mg/0.3m^2)	Mean Density ± S.E. (#/m^2)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	1	0.05	3.33 ± 3.04	0.17 ± 0.15
Branchiura sowerbyi	12	134.06	40.0 ± 13.33	446.83 ± 162.49
Other Tubificidae	612	242.63	2040.0 ± 377.98	808.77 ± 181.08
Naididae	4	0.28	13.33 ± 12.17	0.93 ± 0.85
Hirudinea	-	-	-	-
Isopoda	1	*	3.33 ± 3.04	.
Hydracarina	-	-	-	-
Hexagenia bilineata	-	-	-	-
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	-	-	-	-
Cyrnellus sp.	-	-	-	-

Table 27 cont'd

Taxa	Number Collected ($0.3m^2$)	Biomass Collected ($mg/0.3m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	140	21.1	466.67 ± 85.07	70.33 ± 14.14
Chaoborus sp. pupae	16	3.43	53.33 ± 9.03	11.43 ± 1.40
Chironomidae	202	*	673.33 ± 50.04	.
Ceratopogonidae	2	0.33	6.67 ± 3.16	1.1 ± 1.0
Hydrobiidae	-	-	-	-
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	-	-	-	-
Sphaeriidae	92	64.85	306.67 ± 35.8	216.17 ± 28.07
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	1082	466.73	3606.66	1555.73

* not included in total

- not collected at this site

Bend E
Kuttawa Bend

Site Description

Kuttawa Bend, Bend E, is southeast of the river channel between CRM 40.4 and 41.4 and is directly across from Kuttawa Lake Light. Twelve overbank and ten channel samples were taken (Fig. 7). The overbank grab samples were collected from depths ranging from 3m to 5.5m relative to a lake elevation of 357.8'. The deepest overbank samples taken, 5.5m, were grab #'s 7, 8 and 9. Channel samples were taken from depths ranging from 19.8m (65') to 32m (105'), lake elevation = 357.8'. The channel section parallel to the proposed dredge site was the deepest encountered in this survey.

Empty grabs were retrieved during many grab attempts in the channel adjacent to Bend E. Cobble was taken from the channel floor in one grab, #20E. Little sediment was interspersed among the rocks collected. The empty grabs indicate the possibility that river rock is present in this part of the river because rocks are much less susceptible to collection by Ponar grab than sediment. These rocky areas may have been along steep banks where silt would be less likely to accumulate.

The overbank sediments of Kuttawa Bend have a high percentage of sand, averaging about 64% while the channel, where grab samples were obtained, contains only about 4% sand (Tables 28 and 29). Grab #'s 3E, 4E, 5E and 6E had sand percentages of 81.37, 88.85, 81.64 and 85.15 respectively. Both overbank and channel organic matter (Table 30) were in the range found at other proposed dredge sites.

Macroinvertebrate Analysis

The overbank of Kuttawa Bend supported a diverse fauna with most

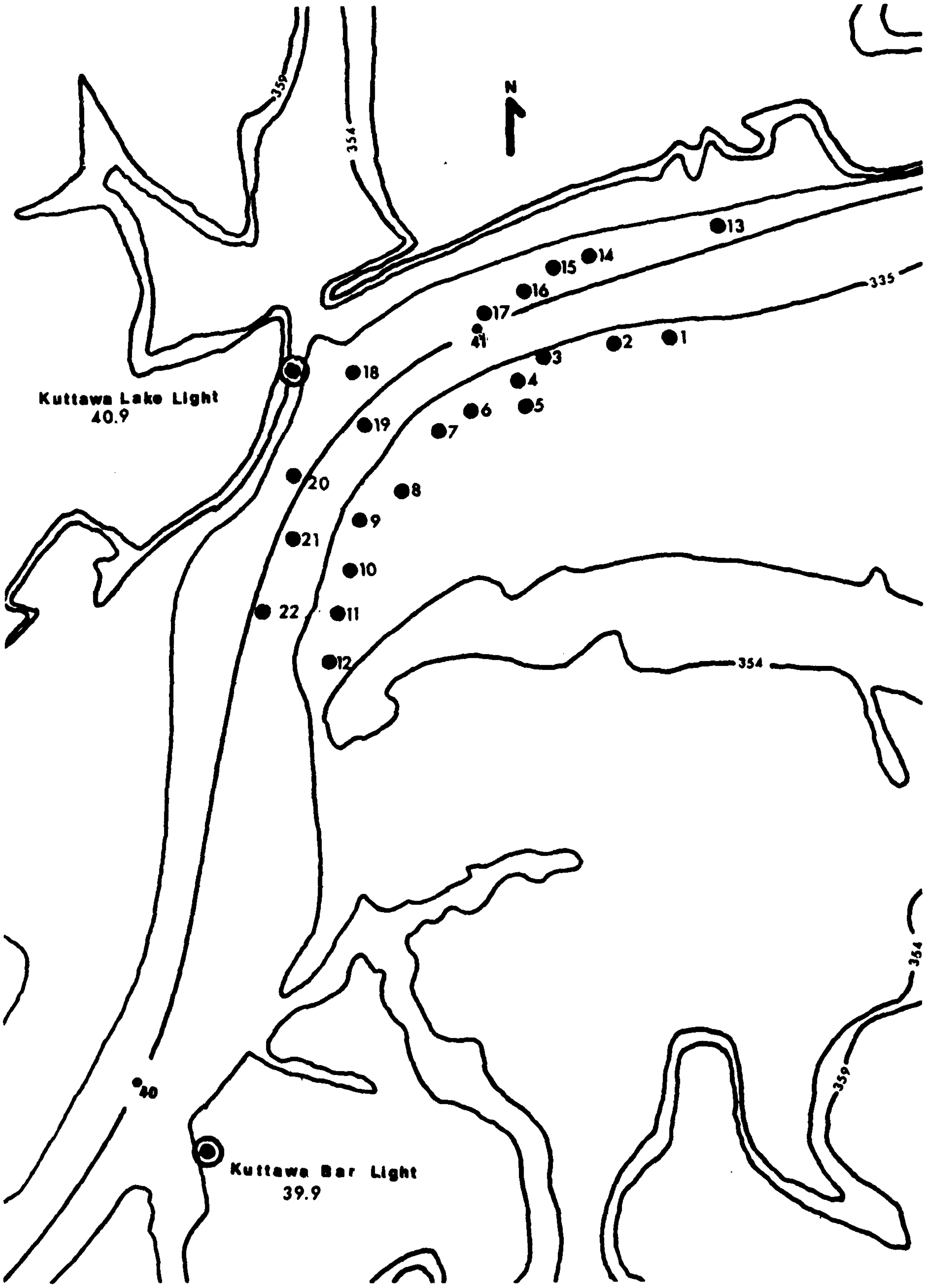


Fig. 7. Grab sample sites for Bend E, Kuttawa Bend.

Table 28. Proposed Kuttawa Bend, Bend E, dredge site sand grain composition.

Grab #	Percent retained by sieve size (mm): 1.0	0.5	0.25	0.125	0.063	Total Sands
1E	0.13	0.13	0.59	30.94	23.84	55.63
2E	0.80	0.09	4.76	45.40	18.65	69.70
3E	0.39	0.54	11.73	54.32	14.39	81.37
4E	0.00	0.15	8.39	60.34	19.97	88.85
5E	0.24	0.67	17.78	47.13	15.82	81.64
6E	5.02	2.81	21.47	40.75	15.10	85.15
7E	0.41	0.23	1.78	21.85	21.35	45.62
8E	2.21	0.35	2.58	29.24	27.48	61.86
9E	6.81	2.22	5.46	23.31	15.85	53.65
10E	0.00	0.74	2.75	30.71	23.62	57.82
11E	0.00	0.00	0.87	14.60	16.87	32.34
12E	0.00	0.00	8.33	36.07	14.92	59.32
Overbank $\bar{x}$	1.33	0.66	7.21	36.22	18.99	64.41
Channel:						
14E	0.00	0.05	0.30	1.36	2.42	4.13
18E	0.00	0.03	1.83	0.39	2.78	5.03
Channel $\bar{x}$	0.00	0.04	1.21	0.87	2.60	4.58

Table 29. Proposed Kuttawa Bend, Bend E, dredge site silt and clay grain composition.

	Percent finer than (mm):					
Grab #	0.062	0.031	0.016	0.008	0.004	0.002
1E	44.37	37.61	31.89	23.34	16.46	11.25
2E	30.36	29.54	24.11	18.44	13.16	8.67
3E	18.63	15.57	12.09	8.86	6.24	5.42
4E	11.14	9.88	8.61	6.87	5.18	3.46
5E	18.34	16.45	12.65	10.04	7.29	4.86
6E	14.85	13.11	11.02	8.42	6.45	4.68
7E	54.37	36.88	29.30	-	22.00	17.25
8E	38.13	40.60	33.71	26.21	18.96	14.16
9E	46.35	45.69	40.39	31.99	23.59	17.84
10E	42.18	37.81	28.81	15.48	21.97	10.77
11E	67.51	53.59	39.10	27.69	20.15	14.71
12E	40.68	40.38	37.22	24.97	19.20	13.71
Overbank $\bar{x}$	35.57	31.42	25.74	18.39	15.05	10.54
Channel:						
14E	95.87	92.93	77.57	62.63	47.42	32.85
18E	94.97	94.67	82.52	66.62	50.70	36.61
Channel $\bar{x}$	95.42	93.80	80.04	64.62	49.06	34.73

Table 30. Proposed Kuttawa Bend, Bend E, dredge site percent sediment organic matter.

Overbank Grab #	% Organic Matter	Channel Grab #	% Organic Matter
1	4.8	13	9.4
2	3.3	14	9.5
3	2.8	15	9.4
4	2.3	16	9.7
5	2.1	17	9.4
6	2.3	18	9.2
7	5.5	19	9.2
8	5.9	20	-
9	6.4	21	9.6
10	12.1	22	9.8
11	5.8	$\bar{x}$	9.5
12	5.9		
$\bar{x}$	4.9		

taxa showing higher densities than at other overbank sites (Table 31). Hexagenia bilineata, concentrated in grabs 8E to 12E, showed a marked increase in density, 66.67 individuals per square meter, at Bend E compared to other bends. Hexagenia also contributed the most to total overbank biomass, its dry weight biomass being 130.58mg/m^2. Other taxa which showed an increase in density at Bend E include tubificid annelids, chironomid larvae and sphaeriid clams. One unionid, a very young Amblema plicata (biomass of 10.61mg), was retrieved in grab #3E, and one shell of Anodonta imbecillis was found in grab 8E. This bend overbank may also be suitable habitat for endangered mussel species and should be sampled more extensively.

The fauna of the channel (Table 32) was similar in composition and density to all other channel areas sampled. Tubificid annelids, 518 individuals per square meter, were the most abundant taxa, but Branchiura sowerbyi, 44 individuals per square meter, contributed most to total biomass having a mean biomass of 448.08mg/m^2.

Table 31 . Density (#/m^2) and biomass (mg/m^2) of macroinvertebrates collected from the overbank of Bend E, Kuttawa Bend (N=12).

Taxa	Number Collected (0.6m^2)	Biomass Collected (mg/0.6m^2)	Mean Density ± S.E. (#/m^2)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	5	0.67	8.33 ± 4.38	1.12 ± 0.70
Branchiura sowerbyi	-	-	-	-
Other Tubificidae	77	23.83	128.33 ± 75.44	39.72 ± 24.46
Naididae	-	-	-	-
Hirudinea	2	0.97	3.33 ± 3.19	1.62 ± 1.54
Isopoda	-	-	-	-
Hydracarina	3	0.21	5.0 ± 3.43	0.35 ± 0.30
Hexagenia bilineata	40	78.35	66.67 ± 29.47	130.58 ± 61.67
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	3	0.31	5.0 ± 3.43	0.52 ± 0.36
Cyrnellus sp.	-	-	-	-

Table 31 cont'd

Taxa	Number Collected ($0.6m^2$)	Biomass Collected ($mg/0.6m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	41	3.07	68.33 ± 35.0	5.12 ± 2.6
Chaoborus sp. pupae	13	1.56	21.67 ± 9.85	2.6 ± 1.37
Chironomidae larvae	518	*	863.33 ± 253.58	.
Chironomidae pupae	12	8.51	20.0 ± 8.16	14.18 ± 6.89
Ceratopogonidae	1	0.13	1.67 ± 1.59	0.22 ± 0.21
Hydrobiidae	6	20.85	10.0 ± 4.41	34.75 ± 15.93
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	1	19.41	1.67 ± 1.6	32.35 ± 30.97
Sphaeriidae	50	57.06	83.33 ± 40.4	95.1 ± 46.58
Amblema plicata	1	10.61	1.67 ± 1.6	17.68 ± 16.93
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	773	225.54	1288.33	375.91

* not included in total

\- not collected at this site

Table 32 Density (#/m^2) and biomass (mg/m^2) of macroinvertebrates collected from the channel of Bend E, Kuttawa Bend (N=10).

Taxa	Number Collected (0.5m^2)	Biomass Collected (mg/0.5m^2)	Mean Density ± S.E. (#/m^2)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	-	-	-	-
Branchiura sowerbyi	22	224.04	44.0 ± 12.9	448.08 ± 148.72
Other Tubificidae	259	75.42	518.0 ± 210.76	150.84 ± 63.05
Naididae	5	0.34	10.0 ± 4.24	0.74 ± 0.34
Hirudinea	1	0.36	2.0 ± 1.9	0.72 ± 0.68
Isopoda	-	-	-	-
Hydracarina	-	-	-	-
Hexagenia bilineata	-	-	-	-
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	-	-	-	-
Cyrnellus sp.	-	-	-	-

Table 32 cont'd

Taxa	Number Collected (0.5m2)	Biomass Collected (mg/0.5m2)	Mean Density ± S.E. (#/m2)	Mean Biomass ± S.E. (mg/m2)
<u>Chaoborus</u> sp. larvae	150	17.78	300.0 ± 53.52	35.56 ± 6.7
<u>Chaoborus</u> sp. pupae		8.11	92.0 ± 13.62	16.22 ± 2.25
Chironomidae larvae	156	*	312.0 ± 71.95	.
Chironomidae pupae	2	2.12	4.0 ± 2.53	4.24 ± 3.07
Ceratopogonidae	-	-	-	-
Hydrobiidae	-	-	-	-
<u>Pleurocera</u> <u>canaliculatum</u> <u>excuratum</u>	-	-	-	-
<u>Corbicula</u> <u>fluminea</u>	-	-	-	-
Sphaeriidae	242	172.07	484.0 ± 107.66	344.14 ± 75.91
<u>Amblema</u> <u>plicata</u>	-	-	-	-
<u>Quadrula</u> <u>nodulata</u>	-	-	-	-
<u>Quadrula</u> <u>quadrula</u>	-	-	-	-
<u>Anodonta</u> <u>imbecillis</u>	-	-	-	-
TOTAL	883	500.24	1766.0	1000.54

* not included in total

\- not collected in this survey

Bend F
Poplar Creek Bend

Site Description

Poplar Creek Bend is approximately one mile in length and is located on the west side of the channel between CRM 39.5 and 40.5. Fifteen overbank and nine channel samples were taken (Fig. 8). Bend F overbank was one of the deepest sampled with depths ranging from 5.2m to 6.7m (18' - 22') at a lake elevation of 357.36'. Channel depths ranged from 15.25m to 23.5m (50' - 77') with the southern channel section near Kuttawa Bar Light having the greater depth (23.5m).

Almost half of the overbank sediment was sand (Table 33) with clay constituting 14% and the remainder being silt (Table 34). Grabs 2F and 3F contained 85.22% and 90.23% sand respectively. In contrast, the downstream overbank grabs, 12F - 15F, contained high percentages of fine-grained particles with silts and clays ranging from 71.87% to 86.8%. The channel substratum averaged only 2.9% sand; silt was the dominating sediment as it was in all of the channel areas sampled. Percent organic matter at overbank and channel sites (Table 35) was similar to that found at the other proposed dredge sites.

Macroinvertebrate Analysis

The faunal composition of Bend F was fairly diverse although densities of macroinvertebrates were similar to other overbank fauna sampled. The most abundant taxon was Chironomidae (536/m^2) while Tubificidae had the next highest mean density (154.67/m^2). The only *Dugesia tigrina* (Platyhelminthes) collected was found in grab 2F. No unionids were found in grabs used for macroinvertebrate analysis; however, two *Truncilla*

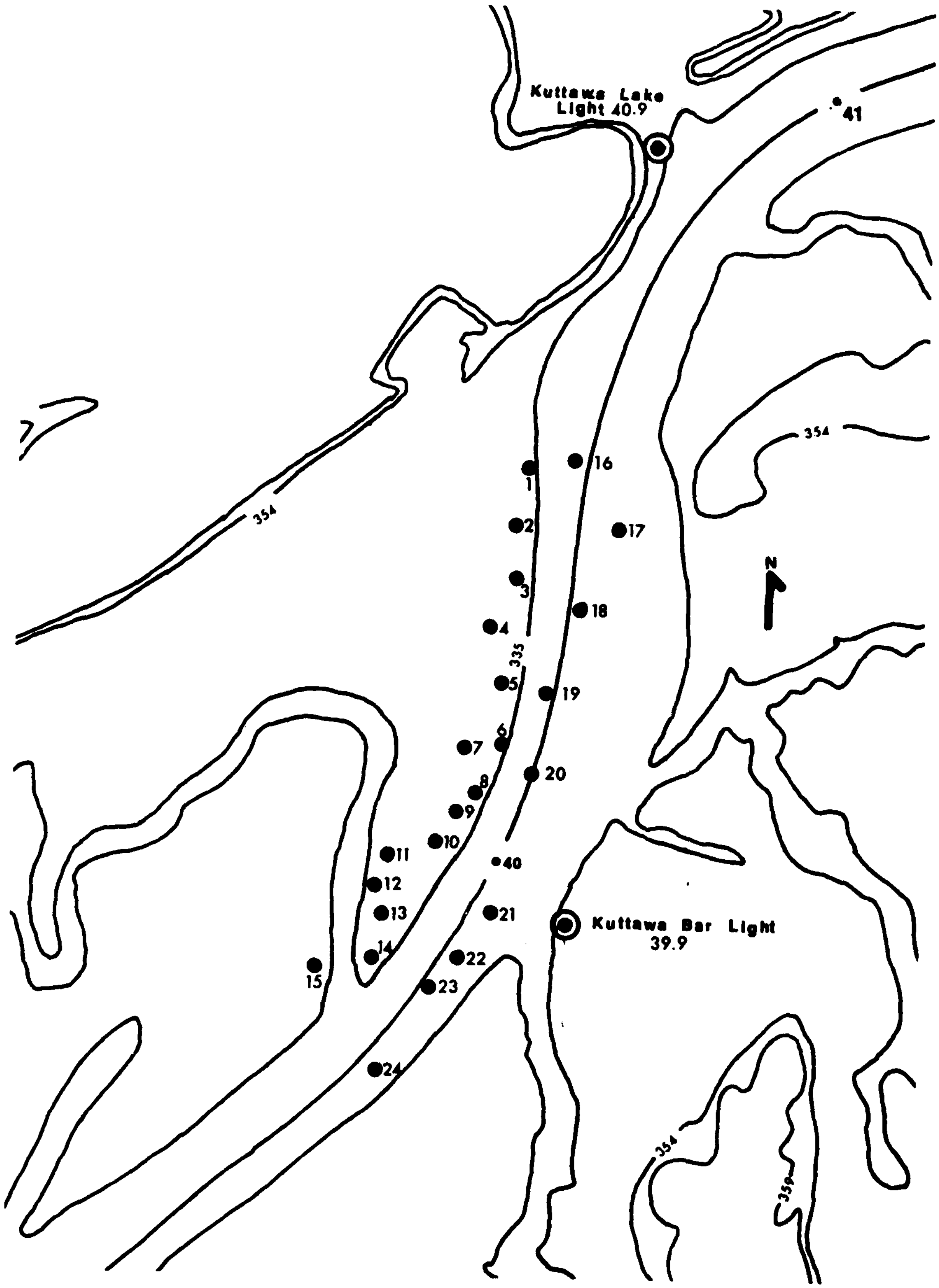


Fig. 8. Grab sample sites for Bend F, Poplar Creek Bend.

Table 33. Proposed Poplar Creek Bend, Bend F, dredge site sand grain composition.

	Percent retained by sieve size (mm):					
Grab #	1.0	0.5	0.25	0.125	0.063	Total Sands
1F	2.66	2.66	24.04	27.98	11.66	69.00
2F	0.35	0.35	17.04	51.13	16.35	85.22
3F	57.15	1.17	11.37	15.18	5.36	90.23
4F	4.32	1.04	15.71	28.54	13.11	62.72
5F	2.37	1.31	11.59	25.30	15.89	56.46
6F	0.29	0.37	6.94	16.50	13.83	37.93
7F	1.50	0.81	19.99	24.83	9.60	56.73
8F	0.74	5.00	31.53	30.18	7.05	74.50
9F	0.00	0.00	5.20	9.45	5.70	20.35
10F	0.00	0.00	8.88	15.25	9.20	33.33
11F	0.00	0.00	6.18	26.62	15.10	47.90
12F	0.00	0.00	2.61	7.75	9.48	19.84
13F	0.00	0.00	0.85	8.70	11.17	20.72
14F	0.74	0.00	1.39	14.76	11.25	28.14
15F	0.00	0.00	0.34	4.45	8.41	13.20
Overbank $\bar{x}$	4.67	0.85	10.91	20.44	10.88	47.75
Channel:						
17F	0.00	0.00	0.23	1.15	2.64	4.02
21F	0.00	0.00	0.05	0.41	1.28	1.74
Channel $\bar{x}$	0.00	0.00	0.14	0.78	1.96	2.88

Table 34. Proposed Poplar Creek Bend, Bend F, dredge site silt and clay grain composition.

	Percent finer than (mm):					
Grab #	0.062	0.031	0.016	0.008	0.004	0.002
1F	31.55	30.06	24.18	18.27	13.27	9.59
2F	14.77	15.10	12.01	9.98	8.15	6.72
3F	9.77	7.83	5.74	4.10	3.04	2.20
4F	37.27	32.52	24.22	16.35	11.57	8.27
5F	43.53	35.76	26.65	18.63	13.36	9.52
6F	62.07	53.88	41.11	28.78	20.33	15.40
7F	43.27	37.15	27.18	19.19	13.76	10.32
8F	25.50	21.51	16.32	12.06	9.00	6.28
9F	79.65	71.81	54.67	37.78	27.46	21.41
10F	66.65	62.00	46.60	40.25	24.19	17.98
11F	52.09	48.29	35.68	24.83	18.72	13.47
12F	80.30	74.36	54.31	38.61	28.38	21.19
13F	79.28	79.99	60.77	41.32	30.96	21.28
14F	71.87	66.66	48.07	32.59	23.75	17.25
15F	86.80	82.48	62.16	43.49	31.56	23.34
Overbank $\bar{x}$	52.29	47.96	35.98	25.75	18.50	13.61
Channel:						
17F	95.98	95.76	81.12	61.77	45.34	31.82
21F	98.25	98.47	87.16	69.06	48.70	34.37
Channel $\bar{x}$	97.11	97.11	84.14	65.41	47.02	33.09

Table 35. Proposed Poplar Creek Bend, Bend F, dredge site percent sediment organic matter.

Overbank Grab #	% Organic Matter	Channel Grab #	% Organic Matter
1	4.0	16	6.7
2	5.9	17	8.5
3	3.7	18	8.4
4	3.6	19	8.7
5	4.4	20	8.4
6	5.2	21	8.7
7	4.2	22	8.9
8	18.9	23	8.7
9	5.1	24	8.7
10	6.2	$\bar{x}$	8.4
11	4.5		
12	5.6		
13	7.0		
14	5.4		
15	4.9		
$\bar{x}$	5.9		

donaciformis were found in grabs (one in 5F and one if 7F) used for sediment analysis. Because they were found in sediment grabs and not invertebrate grabs, the two Truncilla were not included in Table 36 which lists only macroinvertebrates found in invertebrate grab samples.

Although fewer taxa were found in the channel than on the overbank, the channel taxa had relatively high densities (Table 37). Tubificids had a mean density of 4768.89 individuals per square meter and a mean biomass of 1440.93mg/m^2. Other taxa with high densities included *Chaoborus* sp. larvae (884.44/m^2), Chironomidae larvae (520/m^2) and sphaeriid clams (475.55/m^2). Most sphaeriid clams, 109/0.05m^2, were collected in grab 16F. This high density is a result of the characteristics of reproduction in Sphaeriids. The adults retain developing larvae in the inner, marsupial gills and release fully developed juveniles which may remain in the vicinity of the parent for some time.

Table 36. Density (#/m^2) and biomass (mg/m2) of macroinvertebrates collected from the overbank of Bend F, Poplar Creek Bend (N=15).

Taxa	Number Collected (0.75m^2)	Biomass Collected (mg/0.75m^2)	Mean Density $\pm$ S.E. (mg/m^2)	Mean Biomass $\pm$ S.E. (mg/m2)
Dugesia tigrina	1	0.13	1.33 $\pm$ 1.28	0.17 $\pm$ 0.17
Nematoda	3	0.29	4.0 $\pm$ 2.06	0.39 $\pm$ 0.31
Branchiura sowerbyi	2	0.28	2.67 $\pm$ 1.75	0.37 $\pm$ 0.29
Other Tubificidae	116	17.97	154.67 $\pm$ 42.64	23.96 $\pm$ 8.09
Naididae	4	0.06	5.33 $\pm$ 5.15	0.08 $\pm$ 0.08
Hirudinea	2	1.7	2.67 $\pm$ 1.75	2.27 $\pm$ 1.56
Isopoda	-	-	-	-
Hydracarina	3	0.23	4.0 $\pm$ 2.06	0.31 $\pm$ 0.21
Hexagenia bilineata	19	13.58	25.33 $\pm$ 8.32	18.11 $\pm$ 9.15
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	10	1.57	13.33 $\pm$ 4.07	2.09 $\pm$ 0.83
Cyrnellus sp.	-	-	-	-

Table 36 cont'd

Taxa	Number Collected ($0.75m^2$)	Biomass Collected ($mg/0.75m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	75	4.2	100.0 ± 35.12	5.6 ± 1.78
Chaoborus sp. pupae	16	1.83	21.33 ± 1.12	2.44 ± 0.73
Chironomidae larvae	402	*	536.0 ± 97.05	.
Chironomidae pupae	1	1.63	1.33 ± 1.29	2.17 ± 2.1
Ceratopogonidae	2	0.41	2.66 ± 1.75	0.55 ± 0.45
Hydrobiidae	7	31.28	9.33 ± 4.16	41.71 ± 18.5
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	-	-	-	-
Sphaeriidae	13	30.34	17.33 ± 6.76	40.45 ± 18.72
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	676	105.5	901.31	140.67

* not included in total

\- not collected at this site

Table 37. Density (#/m^2) and biomass (mg/m^2) of macroinvertebrates collected from the channel of Bend F, Poplar Creek Bend (N=9).

Taxa	Number Collected (0.45m^2)	Biomass Collected (mg/0.45m^2)	Mean Density ± S.E. (#/m^2)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	3	0.2	6.67 ± 3.14	0.44 ± 0.35
Branchiura sowerbyi	1	10.48	2.22 ± 2.09	23.29 ± 21.96
Other Tubificidae	2146	648.42	4768.89 ±1929.23	1440.93 ± 585.44
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	-	-	-	-
Hexagenia bilineata	3	9.7	6.67 ± 6.28	21.55 ± 20.32
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	-	-	-	-
Cyrnellus sp.	-	-	-	-

Table 37 cont'd

Taxa	Number Collected ($0.45m^2$)	Biomass Collected ($mg/0.45m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	443	38.65	984.44 ± 68.11	85.89 ± 7.54
Chaoborus sp. pupae	42	7.36	93.33 ± 19.12	16.35 ± 3.64
Chironomidae	234	*	520.0 ± 49.99	.
Ceratopogonidae	-	-	-	-
Hydrobiidae	-	-	-	-
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	-	-	-	-
Sphaeriidae	214	131.02	475.55 ± 227.16	291.15 ± 143.6
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	3086	845.83	6857.77	1879.6

* not included in total

\- not collected at this site

Bend G
Money Cliff Bend

Site Description

Money Cliff Bend has the smallest area of the eight bends sampled. It is located on the east side of the channel directly across from Money Cliff Light and extends from CRM 38.8 to 39.2. Only 15 samples were taken, seven from the overbank and eight from the channel (Fig. 9). Overbank sample depths ranged from 4.9m to 6.1m (16' - 20') while channel depths ranged from 19.8m to 23.5m (65' - 77'), lake elevation = 357.12'.

Of all the proposed dredge sites, Bend G had the highest mean percentage of sand, 68% (Table 38). Overbank grab #'s 2G - 5G had over 74% sand. Grab 6G had the highest percentage of fine-grained silts and clays (52.78%). Fine-grained particles made up about 95% of the channel sediments (Table 39). Overbank organic matter was low, 3.1%, compared to the other dredge sites while the channel organic matter was approximately the same as the other channel sites (Table 40).

Macroinvertebrate Analysis

Representatives of only three phyla were found in collections from the Bend G overbank (Table 41). Chironomids were the most abundant taxon although Tubificids and <u>Chaoborus</u> sp. larvae were also common. Chironomids and tubificids were found in each overbank grab taken and <u>Chaoborus</u> sp. was found in six of seven grabs taken. One Hemipteran was collected in grab 1G, but was not identified to genus. The mean overbank sand content, 68%, reveals that this overbank site may be suitable habitat for endangered mussel species and it, along with the overbanks of Bends D and E, should be sampled more extensively to investigate the possibility that endangered mussel species may exist there.

Diversity was low among channel fauna (Table 42), but most taxonomic

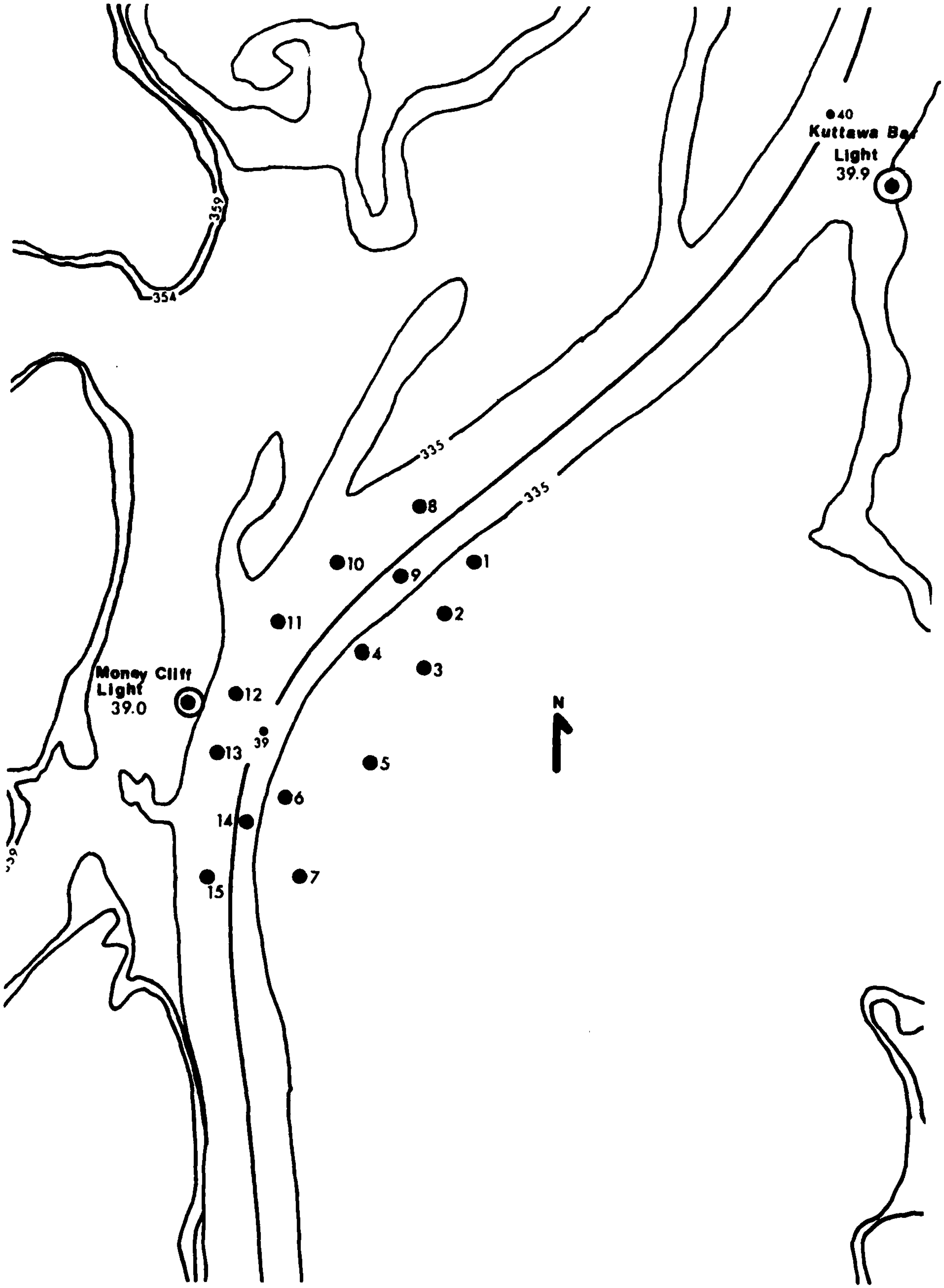


Fig. 9. Grab sample sites for Bend G, Money Cliff Bend.

Table 38. Proposed Money Cliff Bend, Bend G, dredge site sand grain composition.

	Percent retained by sieve size (mm):					
Grab #	1.0	0.5	0.25	0.125	0.063	Total Sands
1G	0.24	0.23	18.40	44.35	6.76	69.98
2G	0.00	0.00	10.54	50.11	14.15	74.80
3G	0.00	0.00	3.16	56.67	16.78	76.61
4G	0.93	0.83	19.61	40.46	14.59	76.42
5G	0.00	0.00	8.65	50.31	17.08	76.04
6G	0.00	0.00	8.12	28.22	10.89	47.23
7G	0.24	0.37	19.36	21.75	11.08	52.80
Overbank $\bar{x}$	0.20	0.20	12.55	41.69	13.05	67.70
Channel:						
8G	0.00	0.00	0.31	1.73	5.04	7.08
13G	0.05	0.00	0.19	0.67	2.10	3.01
Channel $\bar{x}$	0.02	0.00	0.25	1.20	3.57	5.04

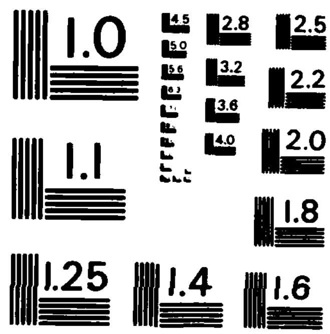
Table 39. Proposed Money Cliff Bend, Bend G, dredge site silt and clay grain composition.

	Percent finer than (mm):					
Grab #	0.062	0.031	0.016	0.008	0.004	0.002
1G	30.02	28.55	21.35	14.31	10.42	7.95
2G	25.19	23.23	16.86	11.76	9.07	6.67
3G	23.39	19.73	14.26	11.12	8.67	7.07
4G	23.58	21.77	16.44	11.96	8.22	6.30
5G	23.95	22.14	16.14	11.41	7.79	5.21
6G	52.78	52.78	39.48	25.81	18.07	14.48
7G	47.19	44.04	30.14	18.89	14.01	10.82
Overbank $\bar{x}$	32.30	30.32	22.10	15.04	10.89	8.36
Channel:						
8G	92.92	90.56	76.06	62.09	48.13	31.84
13G	96.99	97.67	86.03	73.72	58.04	40.72
Channel $\bar{x}$	94.95	94.11	81.04	67.90	53.08	36.28

AD-A161 771 BARKLEY LAKE SURVEY CUMBERLAND RIVER MILES 35 - 47(U) 2/2
MURRAY STATE UNIV KY DEPT OF BIOLOGICAL SCIENCES
J B SICKEL 31 MAR 83 DACW62-81-C-0295

UNCLASSIFIED F/G 8/8 NL

END
FILMED
DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Table 40. Proposed Money Cliff Bend, Bend G, dredge site percent sediment organic matter.

Overbank Grab #	% Organic Matter	Channel Grab #	% Organic Matter
1	2.6	8	7.8
2	2.3	9	8.3
3	2.1	10	8.1
4	3.2	11	8.1
5	3.4	12	8.2
6	4.2	13	8.4
7	3.7	14	8.3
		15	8.2
$\bar{x}$	3.1	$\bar{x}$	8.2

Table 41. Density ($\#/m^2$) and biomass (mg/m^2) of macroinvertebrates collected from the overbank of Bend G, Money Cliff Bend (N=7).

Taxa	Number Collected ($0.35m^2$)	Biomass Collected ($mg/0.35m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	-	-	-	-
Branchiura sowerbyi	9	5.54	25.71 ± 20.88	15.83 ± 12.28
Other Tubificidae	54	8.14	154.28 ± 59.21	23.26 ± 9.13
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	-	-	-	-
Hexagenia bilineata	3	0.65	8.57 ± 7.93	1.86 ± 1.72
Anisoptera	-	-	-	-
Hemiptera	1	0.03	2.86 ± 2.64	0.08 ± 0.08
Oecetis sp.	1	0.01	2.86 ± 2.64	0.03 ± 0.03
Cyrnellus sp.	-	-	-	-

Table 41 cont'd

Taxa	Number Collected (0.35m^2)	Biomass Collected (mg/0.35m^2)	Mean Density $\pm$ S.E. (#/m^2)	Mean Biomass $\pm$ S.E. (mg/m^2)
Chaoborus sp. larvae	45	2.69	128.57 $\pm$ 42.54	7.68 $\pm$ 2.65
Chaoborus sp. pupae	6	0.82	17.14 $\pm$ 13.05	2.34 $\pm$ 1.77
Chironomidae	121	*	345.71 $\pm$ 75.13	.
Ceratopogonidae	-	-	-	-
Hydrobiidae	2	3.33	5.71 $\pm$ 3.41	9.51 $\pm$ 6.36
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	-	-	-	-
Sphaeriidae	3	4.05	8.57 $\pm$ 7.93	11.57 $\pm$ 10.71
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	245	25.26	699.98	72.16

* not included in total

\- not collected at this site

Table 42 Density ($\#/m^2$) and biomass (mg/m^2) of macroinvertebrates collected from the channel of Bend G, Money Cliff Bend (N=8).

Taxa	Number Collected ($0.4m^2$)	Biomass Collected ($mg/0.4m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	-	-	-	-
Branchiura sowerbyi	-	-	-	-
Other Tubificidae	227	68.14	567.5 ± 111.63	170.35 ± 25.17
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	-	-	-	-
Hexagenia bilineata	-	-	-	-
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	-	-	-	-
Cyrnellus sp.	-	-	-	-

Table 42 cont'd

Taxa	Number Collected ($0.4m^2$)	Biomass Collected ($mg/0.4m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	229	23.81	572.5 ± 101.18	59.52 ± 9.78
Chaoborus sp. pupae	9	1.93	22.5 ± 6.55	4.82 ± 1.48
Chironomidae larvae	320	*	800.0 ± 105.0	.
Chironomidae pupae	1	2.49	2.5 ± 2.34	6.22 ± 5.82
Ceratopogonidae	-	-	-	-
Hydrobiidae	-	-	-	-
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	1	0.26	2.5 ± 2.34	0.65 ± 0.61
Sphaeriidae	107	62.21	267.5 ± 55.22	155.52 ± 33.56
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	894	158.84	2235.0	397.1

* not included in total

\- not collected at this site

groups found had relatively high densities. Chironomidae larvae had a mean density of $800/m^2$ while *Chaoborus* sp. larvae and Tubificidae larvae, excluding *Branchiura sowerbyi*, had mean densities of $572.5m^2$ and $567.5/m^2$. One live *Corbicula fluminea* was found in grab 8G.

Bend H
Big Horse Ford Bend

Site Description

Bend H is one of the longest bends proposed to be dredged. The site lies southwest of Carmack Creek Light, CRM 37.0, and north of Big Horse Ford Light, CRM 36.2, and extends from CRM 35.7 to 37.0. Thirty-four samples were taken, 19 from the overbank and 15 from the adjacent channel (Fig. 10). The overbank samples were taken from water depths ranging from 3.3m to 6.1m (10.8' - 20'), lake elevation = 356.94'. Grabs 6H - 14H were taken from water depths of 3.9m or less. Channel samples were taken from depths of 18.3m to 22.3m (60' - 73'), lake elevation = 357.14'.

The Big Horse Ford Bend dredge site had a relatively high percentage of sand (Tables 43 and 44) while the channel had a sand component similar to the other seven bends. In the downstream section of the overbank, which included grabs 15H - 19H, fine-grained silts and clays predominated as opposed to the upstream section where sands were the most abundant particles. Percent organic matter of the overbank and channel (Table 45) was similar to that of the other proposed dredge sites.

Macroinvertebrate Analysis

The faunal composition of Bend H was similar to that of the other bends surveyed; however, density for individual taxa was lower (Table 46). Chironomids were the most abundant taxa, 284.21/m^2, followed by Tubificids, 150.53/m^2, excluding Branchiura sowerbyi. One 3 yr old Quadrula nodulata was found in sediment grab 16H, but was not included in Table 45 because it was not collected in a macroinvertebrate sample. Overbank macroinvertebrates showed no preference for sediment composition even though sediment grab

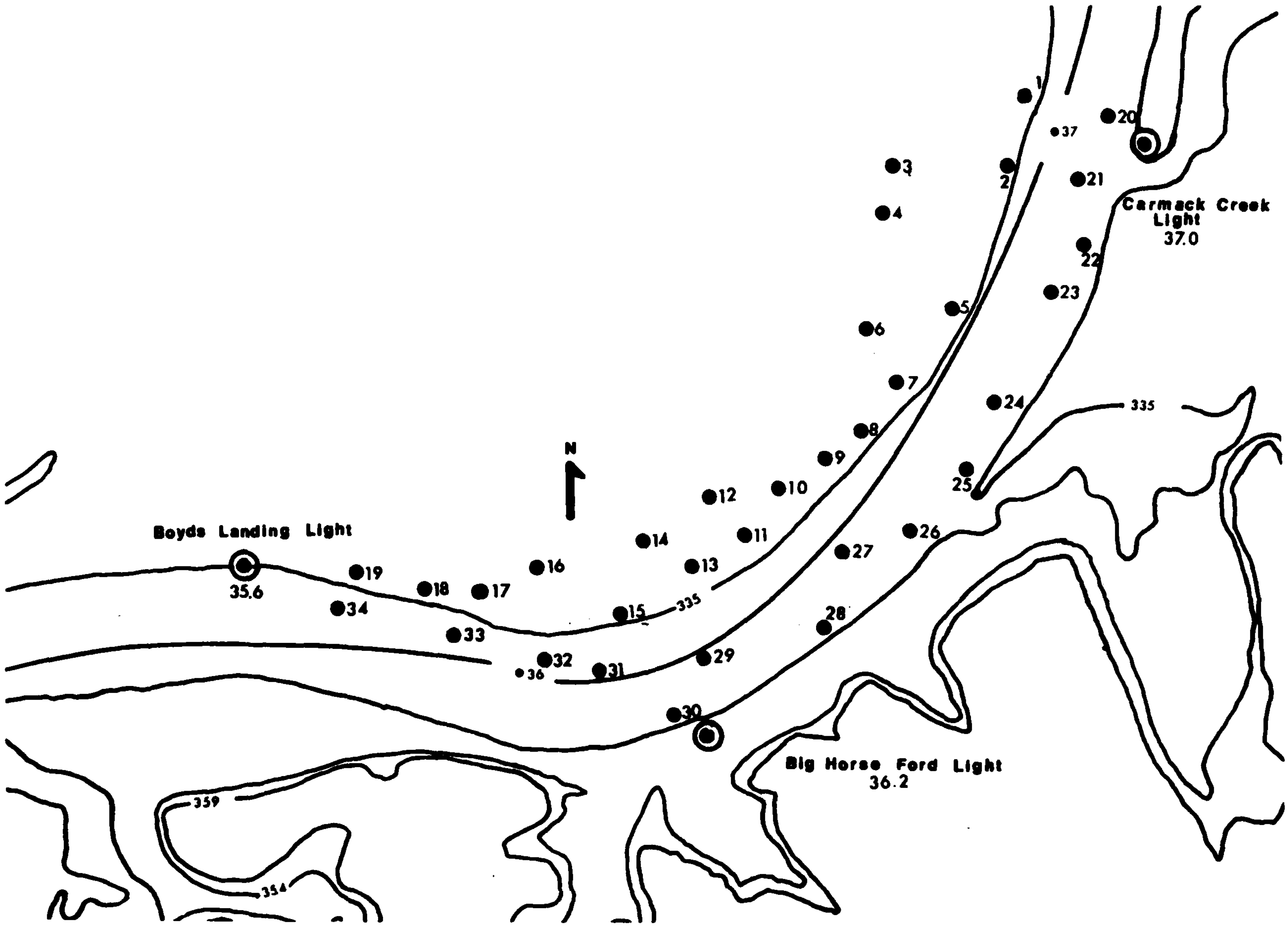


Fig. 10. Grab sample sites for Bend H, Big H[illegible] Ford Bend.

Table 43. Proposed Big Horse Ford Bend, Bend H, dredge site sand grain composition.

	Percent retained by sieve size (mm):					
Grab #	1.0	0.5	0.25	0.125	0.063	Total Sands
1H	1.83	1.10	5.71	36.77	28.03	73.44
2H	0.00	0.00	0.53	7.21	4.85	12.59
3H	0.00	0.00	4.42	41.24	25.30	70.96
4H	0.00	0.00	2.37	32.64	27.11	62.12
5H	0.00	0.00	5.59	34.32	26.58	66.49
6H	0.00	0.00	12.14	34.39	25.70	72.23
7H	0.00	0.00	10.91	37.10	18.43	66.44
8H	0.00	0.00	4.36	46.12	26.29	76.77
9H	0.24	0.00	6.38	46.38	24.05	77.05
10H	0.00	0.00	4.91	42.48	27.90	75.29
11H	0.00	0.00	60.53	26.22	6.28	93.03
12H	0.00	0.00	20.44	38.67	20.92	80.03
13H	0.00	0.00	14.43	33.51	20.46	68.40
14H	0.00	0.00	18.37	27.87	18.48	64.72
15H	0.00	0.00	24.54	0.00	15.93	40.47
16H	2.82	6.46	9.89	18.16	13.64	50.97
17H	0.00	0.00	0.61	9.71	16.77	27.09
18H	0.00	0.00	2.35	17.26	23.45	43.06
19H	0.00	0.00	3.57	33.84	21.21	58.62
Overbank $\bar{x}$	0.26	0.40	11.16	29.68	20.60	62.09
Channel:						
28H	0.00	0.00	0.64	4.59	5.50	10.73
33H	0.00	0.00	0.06	0.44	1.53	2.03
Channel $\bar{x}$	0.00	0.00	0.35	2.51	3.51	6.38

Table 44 . Proposed Big Horse Ford Bend, Bend H, dredge site silt and clay grain composition.

	Percent finer than (mm):					
Grab #	0.062	0.031	0.016	0.008	0.004	0.002
1H	26.56	29.73	18.99	14.95	11.23	7.31
2H	41.16	31.10	25.31	18.82	13.50	9.72
3H	29.03	25.10	18.26	13.19	10.07	6.80
4H	37.88	33.45	23.69	16.68	11.93	8.40
5H	33.51	27.64	20.21	14.90	11.02	7.64
6H	27.77	24.07	17.59	13.00	9.86	7.08
7H	33.55	30.84	23.02	16.97	12.30	8.74
8H	23.22	20.08	14.61	9.66	8.31	5.81
9H	22.95	21.02	16.10	12.60	9.58	7.17
10H	24.71	22.12	16.72	12.81	9.82	7.82
11H	6.96	7.12	5.99	4.91	3.84	3.05
12H	19.97	19.35	14.38	10.48	8.42	5.28
13H	31.60	29.90	23.71	19.22	15.61	12.75
14H	35.27	29.41	21.24	14.90	10.58	7.78
15H	59.53	54.62	44.56	32.11	22.62	16.72
16H	49.02	49.17	35.31	24.08	16.09	11.12
17H	72.91	74.93	56.79	42.89	31.83	24.68
18H	56.94	49.22	35.78	24.11	17.63	11.96
19H	41.38	41.38	33.65	23.75	16.83	12.70
Overbank $\bar{x}$	35.47	32.64	24.52	17.90	13.21	9.61
Channel:						
28H	89.26	87.81	72.79	58.22	39.95	33.01
33H	97.97	95.24	84.52	69.64	54.11	39.47
Channel $\bar{x}$	93.61	91.52	78.65	63.93	47.03	36.24

Table 45. Proposed Big Horse Ford Bend, Bend H, dredge site percent sediment organic matter.

Overbank Grab #	% Organic Matter	Channel Grab #	% Organic Matter
1	3.0	20	8.1
2	2.6	21	8.6
3	2.5	22	7.8
4	2.9	23	7.9
5	2.4	24	7.7
6	2.2	25	8.3
7	2.0	26	6.6
8	2.6	27	6.9
9	2.0	28	6.9
10	2.7	29	7.6
11	1.2	30	7.6
12	2.3	31	7.7
13	2.7	32	8.0
14	2.8	33	8.1
15	4.4	34	6.4
16	6.4	$\bar{x}$	7.6
17	4.9		
18	4.0		
19	3.9		
$\bar{x}$	3.0		

Table 46 . Density ($\#/m^2$) and biomass (mg/m^2) of macroinvertebrates collected from the overbank of Bend H, Big Horse Ford Bend (N=19).

Taxa	Number Collected ($0.95m^2$)	Biomass Collected ($mg/0.95m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	7	0.58	7.37 ± 2.67	0.61 ± 0.32
Branchiura sowerbyi	2	1.71	2.1 ± 1.41	1.8 ± 1.27
Other Tubificidae	143	30.29	150.53 ± 42.82	31.88 ± 9.18
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	1	0.15	1.05 ± 1.02	0.16 ± 0.15
Hexagenia bilineata	9	24.71	9.47 ± 5.02	26.01 ± 17.51
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	4	0.54	4.21 ± 1.87	0.57 ± 0.42
Cyrnellus sp.	-	-	-	-

Table 46 cont'd

Taxa	Number Collected ($0.95m^2$)	Biomass Collected ($mg/0.95m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	34	3.24	35.79 ± 10.79	3.48 ± 0.99
Chaoborus sp. pupae	3	0.5	3.16 ± 2.24	0.53 ± 0.36
Chironomidae	270	*	284.21 ± 41.51	.
Orthocladinae pupae	1	0.87	1.05 ± 1.02	0.53 ± 0.36
Ceratopogonidae	-	-	-	-
Hydrobiidae	2	5.5	2.1 ± 1.41	5.79 ± 4.43
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	-	-	-	-
Sphaeriidae	6	7.3	6.31 ± 3.35	7.68 ± 5.69
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	482	75.39	507.35	79.04

* not included in total

\- not collected at this site

Table 47. Density ($\#/m^2$) and biomass (mg/m^2) of macroinvertebrates collected from the channel of Bend H, Big Horse Ford Bend (N=15).

Taxa	Number Collected ($0.75m^2$)	Biomass Collected ($mg/0.75m^2$)	Mean Density ± S.E. ($\#/m^2$)	Mean Biomass ± S.E. (mg/m^2)
Dugesia tigrina	-	-	-	-
Nematoda	3	0.26	4.0 ± 2.8	0.35 ± 0.28
Branchiura sowerbyi	8	28.91	10.67 ± 4.57	38.55 ± 22.75
Other Tubificidae	224	35.61	298.67 ± 59.49	47.48 ± 9.54
Naididae	-	-	-	-
Hirudinea	-	-	-	-
Isopoda	-	-	-	-
Hydracarina	-	-	-	-
Hexagenia bilineata	-	-	-	-
Anisoptera	-	-	-	-
Hemiptera	-	-	-	-
Oecetis sp.	-	-	-	-
Cyrnellus sp.	-	-	-	-

Table 47 cont'd

Taxa	Number Collected (0.75m^2)	Biomass Collected (mg/0.75m^2)	Mean Density ± S.E. (#/m^2)	Mean Biomass ± S.E. (mg/m^2)
Chaoborus sp. larvae	319	29.17	425.33 ± 46.51	38.89 ± 3.81
Chaoborus sp. pupae	54	7.83	72.0 ± 10.8	10.44 ± 1.54
Chironomidae larvae	248	*	330.67 ± 32.54	.
Tanypodinae pupae	1	1.59	1.33 ± 1.29	2.12 ± 2.05
Orthocladinae pupae	1	2.23	1.33 ± 1.29	2.97 ± 2.87
Ceratopogonidae	1	0.15	1.33 ± 1.29	0.20 ± 0.19
Hydrobiidae	-	-	-	-
Pleurocera canaliculatum excuratum	-	-	-	-
Corbicula fluminea	-	-	-	-
Sphaeriidae	436	327.85	581.33 ± 82.57	437.13 ± 70.49
Amblema plicata	-	-	-	-
Quadrula nodulata	-	-	-	-
Quadrula quadrula	-	-	-	-
Anodonta imbecillis	-	-	-	-
TOTAL	1295	433.6	1726.66	578.13

* not included in total

\- not collected in this survey

samples showed a reduction of sand in a downstream direction.

The channel fauna, though similar to other bends in composition, also showed a decrease in density (Table 47). Mean densities of sphaeriid clams, Chaoborus sp., Chironomidae larvae and Tubificids were 581.33/m^2, 425.33/m^2, 330.67/m^2 and 298.67/m^2 respectively.

General Discussion

Of the 40 macroinvertebrata taxa listed in preceding tables, 39 were collected at the proposed dredge sites (overbanks), and 21 were collected from adjacent channel areas which are potential disposal sites. The difference in diversity between the overbanks and channel areas is to be expected after examination of all sediment samples. The overbanks contain more diverse habitats, and diverse habitats usually host more diverse fauna. Differences in particle size, organic matter, depth and contour occur between overbank sample localities within the same site as well as between sites. In contrast to the overbanks, channel areas were very similar in regard to particle size, organic matter and contour. Depth did fluctuate in the channel but this parameter did not seem to affect the channel macroinvertebrate community or sediment composition.

The channel fauna is restricted to organisms which share a uniform habitat. Organisms normally associated with a muddy habitat are usually highly tolerant to sediment suspensions such as those created by dredging operations. Organisms which are not closely associated with muddy environments are usually more sensitive (Hirsch, et al. 1978). At channel sites, the most abundant organisms were tubificid annelids, chironomid and *Chaoborus* sp. dipterans, and sphaeriid clams. These four taxonomic groups are the major profundal benthic faunal components of most eutrophic lakes (Wetzel 1975). Tubificid annelids occur throughout most lakes with a high percentage of organic matter regardless of depth. In some deep water lakes, tubificids may reach densities of more than 8000/m^2 (Pennak 1978). Many tubificids can tolerate anaerobic conditions for a month or longer if periodically exposed to some oxygenated water. Since tubificids ingest detrital organic

matter and the percent organic matter is usually higher in channel areas, the channel provides an ideal habitat for this family of Oligochaetes. Because of their feeding niche and their ability to withstand low oxygen levels and periodic anaerobic conditions, tubificids which are subjected to dredge overburdens may be able to survive provided the deposited material is in the form of a slurry which would not physically harm the tubificids.

Chaoborus sp. dipterans are abundant throughout most profundal lake systems. This genus is predatory, especially on zooplankton, and food is readily available throughout the lake. They are capable of moving along the sediment surface with erratic body motions and regularly migrate to surface waters at night (Pennak 1978). This mobility might provide a mechanism for escape from dredged material.

Chironomid larvae are chiefly herbivorous although deep water forms may feed mainly on organic detritus in the sediment. These deeper water forms are able to live actively for several months under anaerobic conditions (Pennak 1978) and may be capable of surviving a moderate amount of unconsolidated, dredged material.

The fourth major component of the channel areas, the sphaeriid clams, are much less motile than the preceding taxa. Dredge material would probably suffocate those initially present. The sphaeriids have a short life span (12-18 months), and, although the initial population would be decimated, the sphaeriids should repopulate the area within a year.

The other channel taxa had low densities and biomasses compared to tubificid annelids, Chaoborus sp. larvae, Chironomidae larvae and sphaeriid clams. Their contribution to the lake food chain is much less than the four major groups. The less common taxa also have short life spans and will be replaced quickly by outside recruits after dredging is completed and the

substratum stabilizes.

Motile, sediment-dwelling organisms are often able to move vertically through dredged material. If the dredged material is physically similar to that in which the organism normally occurs, there is usually little problem in vertical migration (Hirsch, et al. 1978). If dredge material and the original site material are different, the fill can be detrimental. Hirsch, et al. (1978) state that "habitat disruption may be minimized by matching the physical characteristics of the dredged material to the substrate found at the disposal site."

Faunal tolerance to suspended sediment usually decreases with increasing temperature and decreasing dissolved oxygen (Hirsch, et al. 1978). The combination of increased summer temperature and low dissolved oxygen levels may be particularly adverse to all aquatic organisms. To minimize faunal intolerance, dredging should be conducted in the winter or early spring months. There is also less biologic activity during the cooler months, and reproduction occurs only in a limited number of species during winter months. This emphasizes the advantages accrued by restricting dredging to cooler months between November and April.

The potential environmental effects of dredging as summarized by Hirsch, et al. (1978) include 1) physical disruption of the bottom resulting in burial or removal of organisms from the original site, 2) bottom topography effects which may change current regimes and sedimentation patterns, 3) suspension of sediments which may smother organisms or place them under physiological stress and which will also have aesthetic impacts, 4) alteration of water quality affecting dissolved oxygen and nutrient content of the water, and 5) release of sediment-bound toxicants which may be toxic to organisms or may accumulate in organisms through the

food web.

Organisms in the immediate dredging area will be exterminated, but, again, they should be replaced by recruitment from neighboring organisms shortly after the dredge site stabilizes. The newly dredged site may or may not have the same sediment composition depending on the horizonal soil layers. The present overbank sediments will be removed by dredging, and it is probable that the overbanks will not regain their former particle size composition after dredging is completed. The present sediments have high percentages of sand which are probably remnants of preimpoundment soils. Because of their size and weight, sands entering the river system from runoff will quickly be deposited along the lake margins. Only smaller sized grains will remain suspended long enough to settle on the overbanks adjacent to the river channel resulting in silt and clay accumulation at the dredge sites which previously contained high percentages of sand. Those species, such as *Pleurocera canaliculatum excuratum*, which are found only in the sand or gravel habitats may not recolonize the post-dredging habitats. These disturbed sites "may be recolonized by opportunistic species which are not normally the dominant species occurring at nearby undisturbed sites" (Hirsch, et al. 1978).

Sediment Composition

The wide range of substratum particle size within each bend (Table 48) is evidence for a lack of uniform habitats with respect to water currents and sediment types within the areas of each bend, Several locations at Bends F and H contained sediments with over 60% sand larger than 0.25mm while other locations at these same bends had less than 0.5% of the sediment that size. It was not determined whether the regions with high percentages of sand resulted from sediment sorting caused by postimpoundment

Table 48. Percentages of sediment composed of medium or larger sand (>.25mm) at eight bends in Barkley Lake.

Bend	A	B	C	D	E	F	G	H
Overbank $\bar{x}$	8.93	17.13	4.06	13.10	9.20	16.43	12.95	11.82
Channel $\bar{x}$	0.64	1.50	0.10	0.21	1.25	0.14	0.27	0.35
Overbank Range								
Maximum	18.89	47.22	21.64	23.79	29.30	69.69	21.37	60.53
Minimum	2.38	1.64	0.71	1.72	0.85	0.34	3.16	0.53

currents or whether the sands were remnants of preimpoundment soils already sorted by river currents. If soil maps could be examined, perhaps a clue to this question could be gleaned.

In general, the overbank sites had 55% of the sediments composed of sands greater than 0.063mm diameter while the channel sites had 94% silt and clay smaller than 0.063mm. The overbank organic content of the sediments (as % loss on ignition at 550°C) averaged just under 5% while the channel sediments contained about 9% (Table 49).

Characteristic Benthic Fauna

Differences in overbank and channel environments influence the distribution of the benthic macroinvertebrates. Table 50 summarizes the density information collected on the predominant invertebrates and those characteristic of specific zones. The highest density and biomass at each bend occurred in the channel (Table 49) but the highest diversity occurred on overbanks. The dominant taxa at both overbank and channel sites were Tubificidae, *Chaoborus* sp. and Chironomidae. Fingernail clams, Sphaeriidae, were abundant at both areas, but more abundant in the channel. Mayfly nymphs, *Hexagenia bilineata*, were abundant on overbanks but uncommon in the channel. Two taxa were common at overbank sites but totally absent from the channel: caddis fly larvae (Tricoptera) and hydrobiid snails.

The chironomid larvae were separated to genera only for the Eddy Creek bend. Table 51 shows the characteristic chironomids found on the overbank and in the channel. Eight genera were identified from the overbank and seven from the channel with nine genera in all being identified. The predominant overbank chironomids consisted of species of *Chironomus*, *Cryptochironomus*, *Polypedilum* and *Procladius* while the predominant channel genera were *Xenochironomus*, *Ablabesmyia*, *Coelotanypus* and *Procladius*.

Table 49. Mean composition of sediment and invertebrate density and biomass at eight bends in Barkley Lake.

Bend	Location	Sands 0.063mm	Silt and Clay 0.063mm	% Organic	Number/m^2	Invertebrate Dry Weight Biomass (mg/m^2)
A	Overbank	57.16	42.41	5.3	1128	783
	Channel	7.76	86.09	8.9	2664	2214
B	Overbank	54.52	45.62	4.3	810	219
	Channel	8.83	91.17	9.1	2909	1241
C	Overbank	38.01	62.05	6.1	617	261
	Channel	2.88	97.11	9.4	2887	978
D	Overbank	51.74	49.08	5.7	449	103
	Channel	4.65	95.56	8.9	3607	1556
E	Overbank	64.41	35.57	4.9	1288	376
	Channel	4.58	95.42	9.5	1766	1000
F	Overbank	47.74	52.29	5.9	901	141
	Channel	2.88	97.11	8.4	6858	1880
G	Overbank	67.70	32.30	3.1	700	72
	Channel	5.04	94.95	8.2	2235	397
H	Overbank	62.09	35.47	3.0	507	79
	Channel	6.31	93.61	7.6	1727	578

Table 50. Characteristic fauna of overbank and channel areas of Barkley Lake (Densities as #/m2).

	Bend Locations							
	A		B		C		D	
Taxa	Ovb.	Ch.	Ovb.	Ch.	Ovb.	Ch.	Ovb.	Ch.
Tubificidae								
Branchiura sowerbyi	4.2	26.0	2.9	79.0	-	-	3.5	40.0
Other Tubificidae	213.3	1583.0	177.1	1846.2	-	-	45.8	2040.0
Ephemeroptera								
Hexagenia bilineata	12.5	10.0	34.3	-	32.2	-	2.4	-
Trichoptera								
Oecetis sp.	5.0	-	12.8	-	3.3	-	3.5	-
Diptera								
Chaoborus sp.	10.8	63.0	91.4	358.5	48.9	520.0	43.5	466.7
Chironomidae	752.5	702.0	451.4	390.8	461.1	462.5	249.4	673.3
Ceratopogonidae	4.2	9.0	-	6.2	1.1	10.0	-	6.7
Mollusca								
Hydrobiidae	72.5	-	2.9	-	1.1	-	45.9	-
Sphaeriidae	39.2	229.0	12.9	246.2	46.7	440.0	5.9	306.7

Table 50 cont'd

Taxa	Bend Locations							
	E		F		G		H	
	Obv.	Ch.	Ovb.	Ch.	Obv.	Ch.	Obv.	Ch.
Tubificidae								
Branchiura sowerbyi	-	44.0	2.7	2.2	25.7	-	2.1	10.7
Other Tubificidae	128.3	518.0	154.7	4768.9	154.3	567.5	150.5	298.7
Ephemeroptera								
Hexagenia bilineata	66.7	-	25.3	6.7	8.6	-	9.5	-
Trichoptera								
Oecetis sp.	5.0	-	13.3	-	2.7	-	4.2	-
Diptera								
Chaoborus sp.	68.3	300.0	100.0	884.4	128.6	572.5	35.8	425.3
Chironomidae	863.3	312.0	536.0	520.0	345.7	800.0	284.2	330.7
Ceratopogonidae	1.7	-	2.7	-	-	-	-	1.3
Mollusca								
Hydrobiidae	10.0	-	9.3	-	5.7	-	2.1	-
Sphaeriidae	83.3	484.0	17.3	475.6	8.6	267.5	6.3	581.3

Table 51. Characteristic chironomid fauna of overbank and channel areas of Eddy Creek Bend, Bend A, Barkley Lake.

Taxa	Overbank Density ($\#/m^2$)	Overbank Dry Weight Biomass (mg/m^2)	Channel Density ($\#/m^2$)	Channel Dry Weight Biomass (mg/m^2)
Chironominae				
Chironomus sp.	212.5	200.7	35.0	32.7
Cryptochironomus sp.	32.5	3.9	-	-
Polypedilum sp.	84.2	2.5	-	-
Xenochironomus sp.	2.5	2.9	19.0	89.4
Tanypodinae				
Ablabesmyia sp.	13.3	2.3	113.0	9.3
Clinotanypus sp.	-	-	1.0	0.9
Coelotanypus sp.	40.0	12.7	414.0	331.1
Procladius sp.	234.2	20.2	111.0	12.4
Tanypus sp.	0.8	0.0	1.0	0.0
Unknown Chironomidae	132.5	32.7	8.0	1.6
Totals	752.5	277.9	702.0	477.4

The nature of the sediments and available food are probably responsible for these differences. Although the total density was similar for both areas ($752/m^2$ vs $702/m^2$) the biomass was much higher in the channel ($277mg/m^2$ vs $477mg/m^2$).

Identifications were made with the aid of references by Beck (1976), Mason (1973), and Simpson and Bode (1980).

Impact of Dredging on Benthic Fauna and Fish

Before an accurate estimate of the impact of dredging in Barkley Lake on the benthic macroinvertebrate fauna and consequently on the fish can be calculated, the annual production of the benthic fauna would have to be known. This would require extensive sampling and knowledge of the life history of all the benthic macroinvertebrate species for at least an annual cycle. In the absence of this information, a rough estimate of the productivity (P) can be obtained from measurements of biomass (B) and reference to $P/\bar{B}$ ratios of similar communities. Recognizing that determination of annual mean biomass requires that samples be taken for a year, and that values may fluctuate greatly from year to year, using a single biomass measurement (as in the present report) can serve to provide only the roughest of estimate for productivity. With that in mind, the following discussion should be useful for making only general conclusions regarding the impact of dredging.

The values given for community biomass in this report are probably not far from the true mean annual biomass. The multivoltine character of species composing the community provides overlapping developmental stages particularly during summer months when the samples were collected. The dry weight biomass for the overbank at Bend A, the Eddy Creek bend, was 7.8 kg/ha and that for the channel was 22.1 kg/ha. Both values exclude the unionid mussels found by divers, and, since the large unionids are

not eaten by fish, their exclusion will have little influence on the results. These values are near the mean (10.9) cited by Wetzel (1983) for 38 U. S. lakes.

The area proposed to be dredged at the Eddy Creek bend is 11.3 ha (28 acres). Using the value of 7.8 kg/ha as the benthic invertebrate biomass, it can be assumed that a total of 88.1 kg dry weight (194.2 lbs) will be lost as a direct result of dredging. Since 1g dry weight is approximately 6g wet weight (Waters 1977), the wet weight loss would be 528.6 kg (1165 lbs). If a worst case scenario is considered in which benthic production at the dredge site is lost for a year, then the lost biomass would be approximately six times the mean biomass, or 3172 kg wet weight (7000 lbs). This results from the expected $P/\bar{B}$ ratio of 6 (Waters 1977). If we assume that of that production about 1/5 would have been consumed by fish and that about 1/2 of the amount consumed would be stored as fish production, then at the worst approximately 320 kg (700 lbs) of fish production would be lost as a direct result of dredging. With an average value to the commercial fisherman of $0.40 per pound, the potential loss would be approximately $280.00 which is obviously insignificant compared to the 1980 - 81 net harvest in Barkley Lake of $286,000.00 (Johnson and Bronte 1982).

Since the channel region contains about three times the invertebrate biomass as that of the overbank, a greater fish production loss would be incurred if dredge spoils were deposited in the channel. But, if a comparable area of the channel were covered as that of the overbank, the loss of fish production would still be insignificant.

The impact of dredging on the surrounding area as a result of silt being carried downstream cannot be estimated. This depends on the method

of dredging and disposal. If procedures are used to minimize the suspension of silt, and if dredging is conducted during winter months when fish are not feeding at significant rates, the impact on the commercial and sport fishery will be insignificant.

Impact on Mussels

The diving survey at Eddy Creek bend revealed the presence of 10 species of mussels with a density of approximately $1/10m^2$. Of the commercially valuable species, *Amblema plicata*, *Quadrula quadrula*, *Quadrula nodulata*, *Megalonaias gigantea* and *Tritogonia verrucosa*, a total of 66 were found in an area of $820m^2$ giving an average density of $1/12m^2$. Dredging the bend which has an area of 11.3ha (28 acres) would destroy approximately 9000 mussels with an estimated commercial value of $2300.

Recruitment and growth of mussels is a slow process. Even if the sediments stabilized quickly at the overbank sites after dredging, it would take at least 10 years for the mussel community to return to its present density and value. A small proportion of the present mussel fauna is over 12 years old and must have been among the first overbank recruits after the lake was formed.

Conclusions

1. No endangered species of mussels were found alive or as shells at any of the eight bends sampled by Ponar grab; however, potentially suitable habitats with a high percentage of sand or characteristic riverine fauna were found at bends B, D, E, F, G and H (CRM 43.8, 42.5, 40.9, 40.0, 39.0 and 36.4 respectively).

2. The density of mussels on the bend overbanks was approximately 1/10m^2 making the Ponar grab unsuitable as a method for sampling the mussel fauna. Sampling by divers is the only feasible method to adequately determine the density and composition of the mussels on overbanks. The abundance of commercially valuable mussels at the Eddy Creek site was 1/12m^2 valued at approximately $0.25 each. This indicates a potential loss of 9000 mussels with a value of $2300 if the 11.3 ha (28 acre) bend were dredged. Mussel recruitment is a slow process, and the present density probably would not return for 10 - 15 years after dredging the bend.

3. The sediments within each bend overbank were quite variable regarding grain size composition. In general, however, the overbank sites had 55% of the sediments composed of sands greater than 0.063mm diameter while the channel sites had 94% silt and clay smaller than 0.063mm. The overbank organic content of the sediments was slightly less than 5%, while the channel sediments contained about 9%.

4. The benthic macroinvertebrate biomass at the Eddy Creek bend overbank was 46.8 kg/ha wet weight. If the 11.3 ha (28 acre) bend were dredged there would be a loss of 528.6 kg (1165 lbs) of invertebrates. The

annual production loss would be approximately 3170 kg (7000 lbs). This loss translates into approximately 320 kg (700 lbs) of fish with a commercial value of approximately $280.00.

5. Disposal of dredge spoil in the channel will bury a dense invertebrate fauna, 22.1 kg/ha (19.7 lbs/acre) dry weight. However, recruitment from surrounding areas should reestablish the fauna within a year. Since there are few mussels remaining in the channel because of siltation, channel disposal will have an insignificant impact on mussels. Clay Creek embayment is filling in rapidly and has a sparse mussel fauna. Disposal in that embayment would have an insignificant impact on mussels.

6. Dredging should be conducted during cooler months from November to April to minimize the negative impact to aquatic fauna. High suspended silt loads would have a much greater impact on reproduction, respiration and feeding during warm months when biological activity is increased.

References

Bates, John M. 1962. The impact of impoundment on the mussel fauna of Kentucky Reservoir, Tennessee River. Am. Midl. Natur. 68:232-236.

Beck, W. M., Jr. 1976. Biology of Larval Chironomids. Florida Dept. Envir. Reg., Tech. Ser. Vol 2(1):1-58.

Burch, J. B. 1982. Freshwater Snails (Mollusca:Gastropoda) of North America. EPA-600/3-82-026. Cincinnati, Ohio. 294 pp.

Chandler, C. C. 1982. A survey and ecological study of the unionid mussel fauna of Kentucky Lake, Kentucky. M. S. Thesis, Murray State University, Murray, KY. 154 pp.

Churchill, E. P., Jr. and S. I. Lewis. 1924. Food and feeding in freshwater mussels. Bull. U. S. Bur. Fish. 39:439-471.

Ellis, M. M. 1931. Some factors affecting the replacement of the commercial fresh-water mussels. U. S. Bur. Fish., Fishery Circular No. 7. Washington. 10 pp.

Folk, Robert L. 1974. Petrology of Sedimentary Rocks. Hemphill Publishing Co., Austin, Texas. 185 pp.

Fuller, S. L. H. 1974. Clams and Mussels (Mollusca:Bivalvia). pp. 215-273 in C. W. Hart and S. L. H. Fuller, eds. Pollution Ecology of Freshwater Invertebrates. Academic Press, New York.

Guy, Harold P. 1969. Techniques of Water-Resources Investigations of the United States Geological Survey. Laboratory Theory and Methods for Sediment Analysis. U. S. Geol. Survey, CHP. C1, Book 5. 58 pp.

Hirsch, Nina D., Louis H. DiSalvo and Richard Peddicord. 1978. Effects of Dredging and Disposal on Aquatic Organisms. Final Report. Technical Report DS-78-5. U. S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi. 41 pp.

Isom, B. G. 1969. The mussel resource of the Tennessee River. Malacologia 7(2):397-425.

Johnson, Donald W. and C. R. Bronte. 1982. Evaluation of the Entanglement Gear Fishery in Lake Barkley and Kentucky Lake in Kentucky. Report to KY Dept. Fish and Wildlife Resources. Proj. No. 2368-R-1. 42 pp.

Marking, L. L. and T. D. Bills. 1980. Acute effects of silt and sand sedimentation on freshwater mussels. In Proc. UMRCC Symp. on Upper Mississippi River Bivalve Mollusks. J. L. Rasmussen, ed., Upper Mississippi River Conservation Committee, Rock Island, Illinois pp. 204-211.

Mason, W. T. 1973. An Introduction to the Identification of Chironomid Larvae. U. S. EPA, Anal. Contr. Lab., Cincinnati, Ohio. 90 pp.

Pennak, Robert W. 1978. Fresh-water Invertebrates of the United States. 2nd ed. John Wiley and Sons. 803 pp.

Pfleiger, W. L. 1975. The Fishes of Missouri. Missouri Dept. of Conservation. 343 pp.

Sickel, J. B. and C. C. Chandler. 1982. Commercial Mussel and Asiatic Clam Fishery Evaluation. Final Report. Ky. Dept. Fish and Wildlife Resources. Proj. No. 2-367-R.

Simpson, K. W. and R. W. Bode. 1980. Common Larvae of Chironomidae (Diptera) from New York State Streams and Rivers with particular Reference to the Fauna of Artificial Substrates. Bull. No. 439, New York State Museum. 105 pp.

U. S. Geological Survey. 1979. Water Resources Data for Kentucky, 1978. U. S. Geological Survey, Water Res. Div., Louisville, KY. 502 pp.

Waters, T. F. 1977. Secondary Production in Inland Waters. Adv. Ecol. Res. 10:91-164.

Wetzel, Robert G. 1975. Limnology. W. B. Saunders Co., New York. 743 pp.

----------------- 1983. Limnology, 2nd ed. W. B. Saunders, New York. xii + 858 pp.

Williams, John C. 1969. Mussel Fishery Investigation, Tennessee, Ohio and Green Rivers. Final Report, Ky. Dept. Fish and Wildlife Res. Proj. No. 4-19-R. 107 pp.

Wilson, C. B. and H. W. Clark. 1914 The mussels of the Cumberland River and its tributaries. U. S. Bur. Fish. Doc. No. 781. 63 pp.

Yokley, P., Jr., and C. H. Gooch. 1976. The effects of gravel dredging on reservoir primary production, invertebrate production and mussel production, Tenn. Wildl. Res. Agency, Nashville, and NOAA-76091401, NTIS No. PB-260 458. 39 pp.

END

FILMED

1-86

DTIC